



Creekside Bible Church

2180 I-25
Castle Rock, CO 80104

Construction Documents Project Manual

November 18, 2024
Architect's Project No.: 24010



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**SECTION 00 3100
AVAILABLE PROJECT INFORMATION**

PART 1 GENERAL

1.01 EXISTING CONDITIONS

- A. Certain information relating to existing surface and subsurface conditions and structures is available to Contractor but will not be part of Contract Documents, as follows:
- B. Geotechnical Report: Geotechnical Evaluation, Creekside Bible Church, 2180 I-25, Castle Rock, Colorado 80104; prepared by Ground Engineering; Project No. 24-3566, dated July 11, 2024.
 - 1. A copy is included immediately following this Section.
 - 2. General Information:
 - a. This report identifies properties of below grade conditions and offers recommendations for the design of foundations and other construction elements, prepared primarily for use of Architect and other design team consultants.
 - b. Recommendations contained in this document shall not be construed as requirements of Contract Documents.
 - c. Interpretation: Report is provided only for information and convenience. Owner and Architect disclaim responsibility for accuracy, true location and extent of subsurface conditions that have been evaluated and reported by others. Owner and Architect further disclaim responsibility for interpretation of report data by Contractor; including but not limited to projecting soil bearing values, rock profiles, soil stability, or presence, level, and extent of underground water or other potentially deleterious substances.
 - d. Applicable Requirements: Specific and variable recommendations contained in this document are subject to acceptance by Owner for incorporation in Contract Documents prepared by Architect and other design team consultants. Comply with requirements specified in Contract Documents for earthwork, paving systems, and other applicable work scope items.

1.02 TESTED ASSEMBLY DATA

- A. Tested assembly data for specified fire-resistive assemblies and systems is required to be provided as part of the building permit documents.
 - 1. This data is included in the Drawings.
- B. Interpretation: Tested assembly data is provided for information and convenience. Owner and Architect disclaim responsibility for data that has been prepared by others. Owner and Architect further disclaim responsibility for interpretation of the data.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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**Geotechnical Evaluation
Creekside Bible Church Expansion
Castle Rock, Colorado**



Prepared For:
Creekside Bible Church
2180 I-25
Castle Rock, Colorado 80104

Attention: Mr. Charles Vaughan

Job Number: 24-3566

July 11, 2024

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical evaluation performed by GROUND Engineering Consultants, Inc. (GROUND) for Creekside Bible Church in support of design of the proposed addition to be constructed along the eastern side of the existing Creekside Bible Church building located at 2180 I-25 in Castle Rock, Colorado. Our study was conducted in general accordance with GROUND's Proposal No. 2405-0855R, dated May 14, 2024.

A field exploration program was conducted to obtain information on the subsurface conditions. Material samples obtained during the subsurface exploration were tested in the laboratory to provide data on the engineering characteristics of the site soils. The results of the field exploration and laboratory testing are presented herein.

This report has been prepared to summarize the data obtained and to present our findings and conclusions based on the proposed developments and the subsurface conditions encountered. Design parameters and a discussion of engineering considerations related to the proposed improvements are included herein. This report should be understood and utilized in its entirety; specific sections of the text, drawings, graphs, tables, and other information contained within this report are intended to be understood in the context of the entire report. This includes the *Closure* section of the report which outlines important limitations on the information contained herein.

This report was prepared for design purposes of Creekside Bible Church based on our understanding of the proposed project at the time of preparation of this report. The data, conclusions, opinions, and geotechnical parameters provided herein should not be construed to be sufficient for other purposes, including the use by contractors, or any other parties for any reason not specifically related to the design of the project. Furthermore, the information provided in this report was based on the exploration and testing methods described below. Deviations between what was reported herein and the actual surface and/or subsurface conditions may exist, and in some cases those deviations may be significant.

**Creekside Bible Church Expansion
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PROPOSED CONSTRUCTION

The following project documents were provided to GROUND by the Client for development of the parameters and considerations in this report:

- **Architectural Site Plan** – *Creekside Bible Church, Renovation & Addition, Presubmittal Review*. Prepared by Lee Architects / Interior Designers.
- **Original Geotechnical Report** – *Subsurface Investigation and Percolation Tests of 2184 South Interstate Highway 25, Douglas County, Colorado. Report No. 99-1950*. Prepared by Castle Rock Design Group, Inc. Dated October 4, 1999.
- **RFP** – *Requirements for Site Boring and Geotechnical Engineering Work. Creekside Bible church Expansion. 2180 S I-25 Castle Rock, Colorado*.
- **Preliminary Building Addition Floor Plan** – *Creekside Bible Church, Renovation & Addition*. Prepared by Lee Architects / Interior Designers. Dated January 1, 2024.
- **Preliminary Grading Plan**

Based on provided plans, we understand an approximate 5,500 square-foot (footprint area), single-story building addition is planned to be constructed along east side of the northwestern building at the site. No below grade levels are planned for the proposed structure. We are unaware of the foundation and floor systems utilized for the existing building at the site; however, the provided geotechnical report recommended shallow foundation and floor systems consisting of spread footings and slabs-on-grade underlain by 10 feet of moisture-treated and compacted site-derived fill. A foundation drainage system was also recommended but we are unaware of whether such a system was designed, constructed, and maintained.

Based on correspondence with the client, we understand the finished floor elevation (FFE) of the existing building is approximately 6,338.75 feet. We assume the proposed building addition finished floor elevation (FFE) will match the existing building. Based on the assumed FFE and provided grading information, we assume minor earthen cuts (up to approximately 1 foot) and earthen fills ranging up to approximately 4 feet will be necessary to achieve proposed building addition FFE. Structure loading information was not provided at the time of this report preparation. We assume structural loads will be relatively light to moderate.

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A fire lane is planned to the east of the proposed building addition. Exterior flatwork (pedestrian sidewalks) and landscaping are also planned.

The project site is shown in Figure 1. **If our described understanding/interpretation of the proposed project is incorrect or project elements differ in any way from that expressed above, including changes to improvement locations, dimensions, orientations, loading conditions, elevations/grades, etc., and/or additional buildings/structures/site improvements are incorporated into this project, either after the original information was provided to us or after the date of this report, GROUND or another geotechnical engineer must be retained to re-evaluate the conclusions and parameters presented herein.**

Performance Expectations Based on our experience with other, similar projects, we assume that post-construction, structure foundation and floor movements on the order of 1 inch are acceptable to, and anticipated by the Creekside Bible Church, as are the resultant distress and maintenance measures. Similarly, we anticipate that movements of somewhat greater magnitude (1 to 2 inches) are acceptable and anticipated for the exterior flatwork, although movement estimates closer to 1 inch may be preferable. Assuming that traffic speeds will be relatively low, still greater movements (3+ inches locally) are acceptable and anticipated for the private pavements. GROUND will be available to discuss the risks and remedial approaches outlined in this report, as well as other potential approaches, upon request if post-construction movements of these magnitudes are not acceptable and anticipated.

SITE CONDITIONS

At the time of our exploration, the project site generally consisted of the existing Creekside Bible Church facility. The area of the proposed building addition consisted generally of a gentle southeast-trending slope with short to medium turf grass. The eastern margin of the existing building (along the western margin of the proposed addition) generally consisted of wood chip mulch with scattered shrubs/bushes and a sidewalk. A storage shed was located



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east of the northeastern corner of the building and was bordered to the north by a block retaining wall (approximately 3 to 4 feet in height). The southern margin of the proposed addition footprint was associated with landscaping gravels and a concrete sidewalk. A pavilion structure with a concrete slab was located near the southeastern corner of the proposed addition. A playground area with



playground structures was noted east of the pavilion and was wrapped by a chain link fence. Landscape gravels and a sidewalk were associated with the playground area. Deciduous trees were scattered throughout the facility but were not located within the proposed addition footprint. Buried utilities at the site were generally located to the south and southeast of the existing building. Based on provided information, we understand septic-related utilities were associated with the proposed addition footprint.

The parking lot generally consisted of asphalt parking areas and drive lanes, with landscaped islands throughout. Overhead parking lot lights were noted within some of the islands. The overflow parking lot to the east of the asphalt pavement was gravel surfaced.

The topography of the site was generally descending to the south and southeast at grades of approximately 1 to 4 percent. A Larger slope was noted along the north side of the existing building with grades ranging up to approximately 10 percent, based on visual estimations.

Cursory observations of the asphalt and concrete surfaces of the parking lot indicated moderate distress which appears to be primarily age related. Cracking and spalling were noted locally in the concrete curb and gutter and flatwork. Patching, seal coat deterioration, and cracking were noted within the asphalt pavement. Fatigue cracking was noted locally. Evidence of previous repairs, including crack sealing, surface seal coating, and local patching were also noted.

SUBSURFACE EXPLORATION

The subsurface exploration for the project was conducted on May 28, 2024. A total of five (5) test holes were drilled with a truck-mounted, continuous flight power auger rig to evaluate the subsurface conditions as well as to retrieve soil samples for laboratory testing and analysis. Four (4) test holes were drilled within/adjacent to the proposed approximate building addition footprint limits to depths ranging from approximately 30½ to 50½ feet below existing grades, and one (1) test hole was drilled within the proposed fire lane to a depth of approximately 5½ feet below existing grade. GROUND directed the subsurface exploration, logged the test holes in the field, and prepared the soil samples for transport to our laboratory.

Samples of the subsurface materials were retrieved with a 2-inch inner diameter California liner sampler and a 1⅜-inch inner diameter standard penetration test sampler. The samplers were driven into the substrata with blows from a 140-pound hammer falling 30 inches, in general accordance with the Standard Penetration Test described by ASTM Method D1586. Penetration resistance values, when properly evaluated, indicate the relative density or consistency of soils. Depths at which the samples were obtained and associated penetration resistance values are shown on the test hole logs.

The approximate locations of the test holes are shown in Figure 1. Logs of the exploratory test holes are presented in Figure 2 and Appendix A. Explanatory notes and a legend are provided in Figure 3. GROUND utilized the Client-provided plans indicating existing features, Google Map imagery and a hand-held GPS to approximately locate the test holes. The elevations of the test holes were estimated from the provided grading plan.

LABORATORY TESTING

Samples retrieved from our test holes were examined and visually classified in the laboratory by the project engineer. Laboratory testing of soil samples obtained from the subject site included standard property tests, such as natural moisture contents, dry unit weights, grain size analyses, and Atterberg limits. Swell-consolidation, unconfined compressive strength, water-soluble sulfate, and corrosivity testing were completed on selected samples. Laboratory tests were performed in general accordance with applicable ASTM and AASHTO protocols. Results of the laboratory testing program are summarized in Tables 1 and 2 and Appendix A.

SUBSURFACE CONDITIONS

The subsurface conditions encountered in the test holes generally consisted of topsoil² (approximately 6 to 7 inches thick) underlain by fill (extending to depths of approximately 5 to 7 feet below existing grades, or to the depth explored in Test Hole P-1). These materials were underlain by native clays which extended to depths ranging from approximately 23 to 30 feet below existing grades. Sands were encountered below the clays which extended to a depth of approximately 47 feet below existing grades in Test Hole 2 and to the depths explored in Test Holes 1, 3, and 4. Clays were encountered at a depth of approximately 47 feet below existing grade in Test Hole 2 and extended to the depth explored.

It should be noted that coarse gravel and cobbles are not well represented in samples obtained from small diameter test holes. At this site, therefore, it should be anticipated that gravels and cobbles may be present in the native soils, even where not included in the general descriptions of the site soil types below.

Fill soils may contain coarse gravels, cobbles, boulder, and similar sized pieces of construction debris. Delineation of the complete lateral and vertical extents of the fills at the site or their composition was beyond our present scope of services. If fill soil volumes and compositions at the site are of significance, they should be further evaluated using test pits.

Fills generally consisted of clays with sands, clayey to silty sands and gravels. The granular fractions consisted of fine to coarse sands and scattered gravels. They were slightly to highly plastic, slightly moist to moist, and dark brown to gray-brown in color. Iron staining was noted commonly.

Clays generally consisted of clays and sandy clays with local clayey to silty sands. The granular fractions consisted of fine sands with scattered medium to coarse sands and gravels. They were slightly to moderately plastic, medium to very stiff / loose to medium dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. Lignite filaments were noted locally.

² 'Topsoil' as used herein is defined geotechnically. The materials so described may or may not be suitable for landscaping or as a growth medium for such plantings as may be proposed for the project.

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Sands generally consisted of sands with clays and silts and silty to clayey sands with local clays. The granular fractions consisted of fine to coarse sands and gravels. They were slightly plastic, medium dense to dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly.

Groundwater was encountered in the test holes at depths ranging from approximately 23 to 29 feet below existing grades at the time of drilling. Water was measured in Test Hole 3 approximately 6 hours after drilling at a depth of approximately 23 feet below existing grade where initially noted at a depth of approximately 29 feet below existing grade. The test holes were backfilled upon drilling completion per Code of Colorado Regulations (2 CCR 402-2). Groundwater levels can be expected to fluctuate, however, in response to annual and longer-term cycles of precipitation, irrigation, surface drainage, nearby rivers and creeks, land use, and the development of transient, perched water conditions. The amount of spring snowmelt, duration and intensity of precipitation, irrigation infiltration, and the subsurface and surface drainage characteristics of the draining area will also impact these fluctuations. The groundwater observations performed during our exploration must be interpreted carefully as they are short-term and do not constitute a groundwater study. In the event the Client desires additional/repeated groundwater level observations, GROUND should be contacted; additional exploration and fees will be necessary in this regard.

Swell-Consolidation Testing of samples of the site materials encountered in the project test holes indicated a relatively low potential for swell and consolidation. Swells ranging up to approximately 0.7 percent and consolidations ranging from approximately 0.2 to 0.3 percent were measured against various surcharge loads approximating in-place overburden pressures (see Table 1 and Appendix A).

ENGINEERING SEISMICITY

Based on extrapolation of available data to depth and our experience in the project area, we consider the site likely to meet the criteria for a Seismic Site Classification of D according to ASCE 7-16 (Table 20.3-1). Actual shear wave velocity testing/analysis and/or exploration to 100 feet was not performed. If, however, a quantitative assessment of the site seismic properties is desired, then shear wave velocity testing should be performed. GROUND can provide a fee estimate for shear wave velocity testing upon request.

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Utilizing the web-based ASCE 7 Hazard Tool (<https://asce7hazardtool.online>) and site latitude and longitude coordinates of 39.330238°N and 104.877569 °W (obtained from Google Earth), respectively, the project area is indicated to possess an S_{DS} value of 0.231 and an S_{D1} value of 0.094.

GEOTECHNICAL CONSIDERATIONS FOR DESIGN

The conclusions and parameters provided in this report were based on the data presented herein, our experience in the general project area with similar structures, and our engineering judgment with regard to the applicability of the data and methods of forecasting future performance. A variety of engineering parameters were considered as indicators of potential future soil movements. Our parameters and conclusions were based on our judgment of “likely movement potentials,” (i.e., the amount of movement likely to be realized if site drainage is generally effective, estimated to a reasonable degree of engineering certainty) as well as our assumptions about the owner’s willingness to accept geotechnical risk. “Maximum possible” movement estimates necessarily will be larger than those presented herein. They also have a significantly lower likelihood of being realized in our opinion, and generally require more expensive measures to address. We encourage Creekside Bible Church upon receipt of this report, to discuss these risks and the geotechnical alternatives with us.

In addition to the risks and remedial approaches presented, Creekside Bible Church, also must understand the risk-cost trade-offs addressed by the civil and structural engineering disciplines in order to direct their design team to the portion of the Higher Cost / Lower Risk – Lower Cost / Higher Risk spectrum in which this project should be designed. If Creekside Bible Church does not understand these risks, it is critical that additional information or clarification be requested so that their expectations reasonably can be met.

Geotechnical Risk In GROUND’s opinion sources of geotechnical risk at the site include the presence of undocumented fill materials, expansive soils, and the nature of the proposed construction.

As discussed, fill materials were penetrated to depths of approximately 5 to 7 feet below existing grades in the test holes. We assume these soils were placed during overlot grading when the original facility was constructed. Although some of these soils may have been placed in a controlled manner, testing records for the fill placement were not

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available for GROUND to review at the time of this report preparation. Additionally, in our experience, fills placed in overlot grading areas are not typically placed with the same level of moisture treatment and compaction as fills placed beneath buildings and other movement sensitive improvements. Therefore, these materials are considered by GROUND to be undocumented fill soils. In undocumented fill soils, there exists a largely unquantifiable risk of volume change of the fill (primarily from consolidation of materials) associated with the presence of unknown materials and voids in the fill. A potential for swell and consolidation was also measured in a tested sample of the shallow fill at the site. We anticipate the majority of the existing fill materials may be reused in project fills provided any deleterious or unsuitable materials encountered are removed and the soils are properly placed.

Another source of geotechnical risk to development at the site is the presence of expansive soils. Swells ranging up to approximately 10½ percent were reported in the original soils report for the facility (prepared in 1999). Where they are present, such expansive earth materials have caused significant and damaging post-construction movements in the greater project area. However, based on our laboratory testing program, relatively low swells, ranging from approximately 0.2 to 0.7 percent, were measured in samples of the shallow soils.

As discussed, we understand the original geotechnical report recommended that shallow footing foundations bear on 10 feet of moisture-treated and compacted fill. Such remedial excavations adjacent to the existing structure are a source of geotechnical risk because they introduce the potential to compromise the bearing and lateral support of existing structure and associated improvements. Vertical excavations adjacent to existing foundation elements will not be feasible without shoring, underpinning, grouting, or other methods to protect the existing building. Constructing a remedial fill section of variable thickness (i.e., sloped down from the margin of the existing structure a safe distance laterally and vertically to the bottom of the fill section) also introduces the risk of differential movements associated with differential fill and would allow existing fills to remain beneath the building addition footprint.

Likely Post-Construction Movements Based on our data, the selected depth of wetting, and our experience with similar sites, we estimate improvements supported directly on the existing site soils are subject to likely, post-construction, vertical movements of 2 to 3

inches or more where improvements bear directly on the existing site earth materials. Lateral movements will result, as well. Foundation and slab/flatwork movements of these magnitudes can result in significant damage. Nearly all of the proposed improvements are vulnerable in this regard.

Specific geotechnical parameters to address the geotechnical risks at the site are provided in subsequent sections of this report. Additional discussion regarding these parameters and the geotechnical risks that they address are provided below.

FOUNDATION AND FLOOR SYSTEMS OVERVIEW

Deep Foundation / Structural Floor System

For the least potential for total and differential movement, the structure should be supported on a deep foundation system consisting of drilled piers or driven piles with a structural floor system. Additionally, building entryways and other attached building appurtenances should ideally be founded on piers the same as the main building structure, to reduce the potential of differential movement. Utilizing this option as well as other applicable information provided in this report, GROUND anticipates potential post-construction foundation movements of approximately ½-inch. As bedrock was not encountered to the depth explored of approximately 50½ feet, we preliminarily anticipate drilled pier lengths of 60 feet or more. GROUND should be contacted if parameters for drilled pier design are desired. An additional mobilization and subsurface exploration will be necessary in such a case.

Helical Pier Foundation / Structural Floor System

As another alternative, the building and floor could be supported on helical piers or similar, proprietary, deep foundation systems.

We suggest contacting the following designer/contractors for additional information and a foundation design, although others may be available.

- **DRS Engineering Contractors** (Highlands Ranch, Colorado) (303) 306-9200
- **Keller** (Commerce City, Colorado) (303) 469-1136
- **Park Range Construction** (Englewood, Colorado) (303) 781-8936

- **Schnabel Foundation Company** (Aurora, Colorado) (303) 696-7268

We anticipate that elements of these systems will bear in the sands beneath the site and that void forms at least 6 inches in thickness will be used. The actual bearing depth, element capacity, and other parameters used for design of the selected system; however, must be determined by the specialty designer/contractor.

It should be noted that these proprietary systems will be designed by an engineer associated with the specialty company that installs them. In that regard, this report may be relied upon by the specialty designer/contractor as a data report, only. We anticipate that the data in this report will be sufficient for the specialty designer/contractor to design the foundations, but if additional data are needed, the designer/contractor should obtain the necessary subsurface exploration, testing, etc.

As proprietary foundation systems designed and installed by others, GROUND cannot comment on the appropriateness or the anticipated performance of these systems. We cannot establish criteria for acceptance of a system, or “accept” or “approve” an installation. In particular, we are not able to comment on a given foundation element that was not installed per the designer/contractor’s plan.

Shallow Foundation / Slab-on-Grade Floor System – Rammed Aggregate Piers

As an alternative, the site soils could be densified in-place by installation of rammed aggregate piers, e.g., “Geo-piers” or “Vibro Piers.” It is GROUND’s opinion that rammed aggregate piers could be utilized to improve the site subgrade soils and reduce the potential for settlement without construction of a uniform fill prism. If utilized, the rammed aggregate piers should be installed to support both the footings and slab.

Rammed aggregate pier installation typically consists of either a drilled shaft, backfilled with coarse aggregate in lifts and compacted with a high frequency tamper or displacement using a down hole vibrator to compact aggregate in-place in controlled lifts. This has the effect of densifying the surrounding soils, increasing bearing capacity and reducing post-construction settlements for elements supported on them. Installation of rammed aggregate piers/vibro-piers should be considered beneath any proposed improvements sensitive to post-construction movements.

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Based on our experience and conversations with industry representatives, we understand estimated, post-construction settlements/heave of approximately 1 inch may be achievable if the available geotechnical data, foundation plan, structural loads, and movement tolerances are supplied to the design/build contractor. We understand rammed aggregate pier systems are capable of providing allowable bearing pressures of 4,000 to 6,000 psf or more, with associated settlements of approximately 1 inch. The actual bearing pressures, etc., for shallow foundations as well as potential post-construction movement estimates (foundations and floor slabs) should be provided by the designer/contractor.

Rammed aggregate pier systems are proprietary foundation systems and the element layout and design parameters will be provided by the specialty designer/contractor. The data in this report should be sufficient for the designer/contractor to develop their design. We suggest contacting either of the following designer/contractors, although other may be available:

- **Ground Improvement Engineering** – “Geopiers” (816) 421-4334
- **Keller** – “Vibro Piers (303) 469-1136

Quality control observation of rammed aggregate pier installation, as well as vibration monitoring of nearby structures sensitive to vibration and settlement can be beneficial during project construction. GROUND is available to provide installation observation and vibration monitoring upon request under separate contract.

It should be noted that these proprietary systems will be designed by an engineer associated with the specialty company that installs them. In that regard, this report may be relied upon by the specialty designer/contractor as a data report, only. We anticipate that the data in this report and in this report will be sufficient for the specialty designer/contractor to design the foundations, but if additional data are needed, the designer/contractor should obtain the necessary subsurface exploration, testing, etc.

As proprietary foundation systems designed and installed by others, GROUND cannot comment on the appropriateness or the anticipated performance of these systems. We cannot establish criteria for acceptance of a system, or ‘accept’ or ‘approve’ an installation. In particular, we are not able to comment on a given foundation element that was not installed per the designer/contractor’s plan.

Shallow Foundation / Slab on Grade Floor System – Fill Prism

As an alternate foundation and floor system (but not equal in performance), a shallow foundation and floor system consisting of spread footings and a slab-on-grade floor system may be utilized for the proposed structure provided over-excavation is performed and a remedial uniform fill thickness (fill prism) is constructed beneath and beyond the structure in order to reduce (but not eliminate) the potential for movement (heave/settlement). The fill prism may consist of site-generated soils or approved import materials placed in a moisture-density treated manner (see the *Project Earthwork* section of this report). Due to the potential for heave and settlement, a remedial uniform fill prism **of at least 10 feet in thickness** should be constructed beneath the underslab gravel layer.

The remedial uniform fill prism should extend laterally approximately 10 feet beyond the building and beneath any building appurtenances including entryways, patios, courtyards, etc., except where excavations would extend underneath the foundations of the existing structure. Utilizing this option as well as other applicable suggestions provided in this report, GROUND estimates potential movements associated with heave and/or settlement on the order of approximately 1 inch and differential movements on the order of ½ inch over a distance of 40 feet. Realized movements may exceed these estimates resulting in distress and subsequent repairs. Geotechnical parameters for shallow foundations are provided in the *Foundation Systems* section of this report. Geotechnical parameters for slab-on-grade floors are provided in the *Floor Systems* section of this report.

Additional Considerations

- If a remedial fill prism is constructed to remove and replace all of the existing fills beneath the proposed building addition, a structural engineer should evaluate the effects of the removal of the excavated soil on the existing building and associated improvements. Temporary shoring of the existing building and improvements is also anticipated to be necessary in this regard. Additionally, appropriate measures should be planned prior to construction and implemented during construction to prevent damage to the existing structure and associated improvements. Undermining of the soils supporting existing foundations and other improvements should be prevented. Additionally, the use of geotechnical instrumentation (vibration monitoring,

inclinometers, etc.) in conjunction with pre-construction building distress surveys may be useful in this regard.

- In the event the Client selects to construct a uniform fill prism to support shallow foundations, the performance of the structures will be strongly controlled by the quality of the as-constructed fill prism. Effective and consistent fill placement will be necessary to ensure the fill section is uniformly constructed. Variations in fill density, moisture content, etc. will result in variable performance and may increase differential movements.
- Inadequate site drainage and/or ineffective fill processing will also result in an increase in the movement estimates provided. In addition, realized movements may be more or less depending on the subsurface materials present and the overall site drainage after construction is completed and landscape irrigation commences. In the event the earth materials supporting the proposed building's foundation and floor systems experience moisture infiltration, post-construction movements in excess of those provided herein should be anticipated.

FOUNDATION SYSTEMS

The geotechnical parameters below may be used for design of foundations for the proposed structure, selected based on acceptance of the risks discussed in the Geotechnical Considerations for Design and Foundation and Floor Systems Overview sections of this report.

Shallow Foundations

Geotechnical Parameters for Shallow Foundation Design

- 1) Footings should bear on a fill prism consisting of properly moisture-conditioned and compacted site-generated materials /approved import materials or rammed aggregate piers, as discussed in the *Foundation and Floor System Overview* section. The fill prism should extend laterally at least 10 feet beyond the perimeter of the building (sides not connected to the existing building).

Considerations for fill placement and compaction are provided in the *Project Earthwork* section of this report.

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The fill section, if selected, should be laterally consistent and of uniform thickness to reduce differential, post-construction foundation movements. A differential fill section will tend to increase differential movements.

The contractor should provide survey data of the excavation beneath the building indicating the depth and lateral extents of the remedial sub-excavation.

- 2) Footings bearing on properly moisture-conditioned and compacted site-generated materials or approved import materials may be designed for an allowable soil bearing pressure of 1,500 psf for footings up to 7 feet in width. In the event the footing width is greater than 7 feet, we should be notified to reevaluate these parameters.

These values may be increased by $\frac{1}{3}$ for transient loads such as wind or seismic loading. For larger footings, a lower allowable bearing pressure may be appropriate.

Compression of the bearing soils for the provided allowable bearing pressure is estimated to be 1 inch, based on an assumption of drained foundation conditions. If foundation soils are subjected to an increase/fluctuation in moisture content, the effective bearing capacity will be reduced and greater post-construction movements than those estimated above may result.

This estimate of foundation movement from immediate compression of the foundation soils is a component of the total, likely, post-construction movement estimated for the buildings at this site. (See the *Geotechnical Considerations for Design* and *Foundation and Floor Systems Overview* sections of this report.) It is in addition to movements from post-construction volume change in the native soils underlying the site and from densification of the fill section constructed beneath the building, as discussed above.

To reduce differential settlements between footings or along continuous footings, footing loads should be as uniform as possible. Differentially loaded footings will settle differentially.

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Footings bearing on soils improved by rammed aggregate piers may be designed for an allowable soil bearing pressure to be determined by the rammed aggregate pier designer/installer. The designer/installer of the system should also provide associated estimated post-construction movements.

- 3) Spread footings should have a minimum lateral dimension of 16 or more inches for linear strip footings and 24 inches for isolated pad footings. Actual footing dimensions should be determined by the structural engineer.
- 4) Footings should bear at an elevation 3 or more feet below the lowest adjacent exterior finish grades to have adequate soil cover for frost protection
- 5) Continuous foundation walls should be reinforced as designed by a structural engineer to span an unsupported length of at least 10 feet.
- 6) Geotechnical parameters for lateral resistance to foundation loads are provided in the *Lateral Earth Pressures* section of this report.
- 7) Connections of all types must be flexible and/or adjustable to accommodate the anticipated, post-construction movements of the structure.
- 8) To the extent possible, utility lines should not be routed under shallow foundations, particularly isolated pad foundations, nor in the soils supporting the foundations. Where doing so cannot be avoided, there is increased risk to both the pipe and the foundation. Measures should be included in design to protect both the footings from increased settlement (such as backfilling the utility trench with Controlled Low Strength Material" (CLSM), i.e., a lean, sand-cement slurry ("flowable fill") or a similar material) and to protect the pipe from deformation.

Where utility lines penetrate footings or stem walls, etc., measures should be included to accommodate the likely total and differential, post-construction movements discussed in this report. Some footings also may experience lateral displacements as structural loads are applied.

Shallow Foundation Construction

- 9) The contractor should take adequate care when making excavations not to compromise the bearing or lateral support for nearby improvements.
- 10) Care should be taken when excavating the foundations to avoid disturbing the supporting materials particularly in excavating the last few inches.
- 11) Footing excavation bottoms may expose loose, organic or otherwise deleterious materials, including debris. Firm materials may become disturbed by the excavation process. All such unsuitable materials should be excavated and replaced with properly compacted fill or the foundations deepened.
- 12) Foundation-supporting soils may be disturbed or deform excessively under the wheel loads of heavy construction vehicles as the excavations approach footing bearing levels. Construction equipment should be as light as possible to limit development of this condition. The movement of vehicles over proposed foundation areas should be restricted.
- 13) All foundation subgrade should be properly moisture-density treated prior to placement of concrete.
- 14) Fill placed against the sides of the footings should be properly compacted in accordance with the *Project Earthwork* section of this report.

FLOOR SYSTEMS

The geotechnical parameters below may be used for design of floors for the proposed structure, selected based on acceptance of the risks discussed in the Geotechnical Considerations for Design and Foundation and Floor Systems Overview sections of this report.

Slab-on-Grade Floors

Geotechnical Parameters for Slab-on-Grade Floors

- 1) Prior to placement of lightly loaded slabs, construction of a uniform fill prism or improved by installation of rammed aggregate piers as discussed in the

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Foundation and Floor System Overview section, should be performed below the bottom of the underslab gravel layer, unless a rammed aggregate pier or other proprietary foundation system is selected. The fill section should extend at full depth at least 10 feet laterally beyond the slab perimeter.

- 2) An allowable subgrade vertical modulus (K) of 65 pci may be utilized for lightly loaded slabs supported by the site soils. This value is for a 1-foot by 1-foot plate; it should be adjusted for slab dimension. If rammed aggregate piers are constructed, the vertical modulus of subgrade reaction should be determined by the rammed aggregate pier designer/installer.
- 3) The prepared surface on which the slabs will be cast should be observed by the Geotechnical Engineer prior to placement of reinforcement. Exposed loose, soft, or otherwise unsuitable materials should be excavated and replaced with properly compacted fill, placed in accordance with the *Project Earthwork* section of this report. All slab subgrade should be properly moisture-density treated prior to placement of concrete.
- 4) Slabs should be separated from all bearing walls and columns with slip joints, which allow unrestrained vertical movement.
- 5) Joints should be observed periodically, particularly during the first several years after construction. Slab movement can cause previously free-slipping joints to bind. Measures should be taken to assure that slab isolation is maintained in order to reduce the likelihood of damage to walls and other interior improvements.
- 6) Interior partitions (if applicable) resting on floor/concrete slabs should be provided with slip joints so that if the slabs move, the movement cannot be transmitted to the upper structure. This detail is also important for wallboards and door frames. A slip joint, which will allow at least 2 or more inches of vertical movement, is recommended. If slip joints are placed at the tops of walls, in the event that the slabs move, it is likely that the wall will show signs of distress, especially where the slabs meet the exterior wall.
- 7) Concrete slabs-on-grade should be placed on properly prepared subgrade. They should also be constructed and cured according to applicable standards and be

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provided with properly designed and constructed control joints. The design and construction of such joints should account for cracking as a result of shrinkage, tension, and loading; curling; as well as proposed slab use. Joint layout based on the slab design may require more frequent, additional, or deeper joints, and should also be based on the ultimate use and configuration of the slabs. Areas where slabs consist of interior corners or curves (at column blockouts or around corners) or where slabs have high length to width ratios, high degree of slopes, thickness transitions, high traffic loads, or other unique features should be carefully considered. The improper placement or construction of control joints will increase the potential for slab cracking. ACI, AASHTO, and other industry groups provide many guidelines for proper design and construction of concrete slabs-on-grade and the associated jointing.

- 8) Slabs should be adequately reinforced. Structural considerations for slab thickness, jointing, and steel reinforcement in floor slabs should be developed by the Structural Engineer. Placement of slab reinforcement continuously through the control joint alignments will tend to increase the effective size of concrete panels and reduce the effectiveness of control joints.
- 9) All plumbing lines should be carefully tested before operation. Where plumbing lines enter through the floor, a positive bond break should be provided. Flexible connections allowing 2 or more inches of vertical movement should be provided for slab-bearing mechanical equipment.
- 10) Moisture can be introduced into a slab subgrade during construction and additional moisture will be released from the slab concrete as it cures. Placement of a properly compacted layer of free-draining gravel, 4 or more inches in thickness, beneath the slabs should be performed. This layer will help distribute floor slab loadings, ease construction, reduce capillary moisture rise, and aid in drainage. The free-draining gravel should contain less than 5 percent material passing the No. 200 Sieve, more than 50 percent retained on the No. 4 Sieve, and a maximum particle size of 2 inches. It has been our experience that the use of CDOT Class 5 or 6 Aggregate Base Course (ABC) has been employed as a base layer for concrete slabs on grade. While CDOT Class 5 or 6 ABC is not an equivalent to the free-draining gravel discussed above and does not provide an equivalent

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degree of capillary break, it is often used to address ACI's recommendation for a coarse-grained, granular base material that is easily trimmable and has a relatively low fines (percent passing #200 sieve) content.

- 11) A vapor barrier beneath a building floor slab is beneficial with regard to reducing sub-slab moisture vapor transmission through the floor slab and into the building, but can retard downward drainage of construction moisture. Elevated vapor fluxes can be detrimental to the adhesion and performance of many floor coverings and can also contribute to other moisture-induced concerns. Thus, an effective sub-slab vapor barrier is a published industry requirement for most slab-on-ground construction (i.e., IBC, ASTM), regardless of project location, soil conditions, and water table depth.

Per ACI 302.2R-15, a vapor barrier is recommended under concrete slabs-on-ground when they will receive (or could receive in the future) moisture-sensitive floor coverings, coatings, adhesives, underlayments, and/or stored goods. Moreover, ACI recommends a vapor barrier for any building which will be humidity or climate controlled, including exposed slabs (such as industrial warehouse). ACI 302 provides further guidance on the location of the vapor barrier beneath the slab.

However, when slabs are placed directly on the vapor barrier, considerations and steps may be needed to help reduce uneven drying/shrinkage concerns and potential slab curl.

Therefore, the owner, the architect, and/or contractor should weigh many considerations when designing and implementing the sub-slab vapor barrier system, including building use and operating conditions, flooring products, sub-base (gravel layer) type, size, and thickness, expected construction traffic, etc.

When a vapor barrier is used, it should consist of a minimum 15-mil thickness, extruded polyolefin plastic (no recycled content or woven materials), maintain a permeance less than 0.01 perms per ASTM E96 or ASTM E1249 before and after mandatory conditioning testing, and comply with ASTM E1745-17 (Class "A"). Vapor barriers should be installed in accordance with ASTM E1643-18 and the manufacturer's guidelines. (Note that Polyethylene ("poly") sheeting (even if 15

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mils in thickness which polyethylene sheeting commonly is not) does not meet the ASTM E1745 criteria and generally should not be used as a vapor barrier material.)

Slab movements are directly related to the increases in moisture contents to the underlying soils after construction is completed. The precautions and parameters itemized above will not prevent the movement of floor slabs if the underlying materials are subjected to moisture fluctuations. However, these steps will reduce the damage if such movement occurs.

LATERAL EARTH PRESSURES

Values for equivalent fluid pressures and the coefficient for frictional resistance to sliding are provided below. These values were approximated based on a moist unit weight (γ') of 120 pcf and an angle of internal friction (Φ) of 18 degrees for site soils reworked as properly compacted fill. These values are based on a drained condition and are unfactored. Appropriate factors of safety should be included in design calculations. Representative samples of the materials proposed for import should be tested and approved prior to transport to the site.

Shallow Elements Resisting Lateral Loads A friction coefficient of **0.22** between a shallow element and the site soils may be used for design of shallow elements and thrust blocks resisting lateral loads.

Passive soil pressure at this site may be estimated using an equivalent fluid pressure of **185 pcf** for drained conditions, to a **maximum of 1,850 psf**. The upper 1 foot of embedment should be neglected for passive resistance. Where passive pressure is used to resist lateral loads, it should be understood that significant lateral strains will be required to mobilize the full value indicated above, likely 1 inch or more; however, a reduced passive pressure can be used for reduced anticipated strains.

At-Rest and Active Lateral Earth Pressures Site soils placed as backfill against a structure in an **at-rest** condition may be considered to exert an equivalent fluid unit weight of **83 pcf**.

Site soils placed as backfill where the full, **active** earth pressure condition applied may be considered to exert an equivalent fluid unit weight of **64 pcf**.

WATER-SOLUBLE SULFATES

The concentration of water-soluble sulfates measured in a selected sample retrieved from the test holes was approximately 0.04 percent (See Table 2). Such a concentration of water-soluble sulfates represents a negligible environment for sulfate attack on concrete exposed to these materials. Degrees of attack are based on the scale of ‘negligible,’ ‘moderate,’ ‘severe’ and ‘very severe’ as described in the “Design and Control of Concrete Mixtures,” published by the Portland Cement Association (PCA). The Colorado Department of Transportation (CDOT) utilizes a corresponding scale with 4 classes of severity of sulfate exposure (Class 0 to Class 3) as described in the published table below.

**REQUIREMENTS TO PROTECT AGAINST DAMAGE TO
CONCRETE BY SULFATE ATTACK FROM EXTERNAL SOURCES OF SULFATE**

| Severity of Sulfate Exposure | Water-Soluble Sulfate (SO₄) In Dry Soil (%) | Sulfate (SO₄) In Water (ppm) | Water Cementitious Ratio (maximum) | Cementitious Material Requirements |
|-------------------------------------|---|--|---|---|
| Class 0 | 0.00 to 0.10 | 0 to 150 | 0.45 | Class 0 |
| Class 1 | 0.11 to 0.20 | 151 to 1500 | 0.45 | Class 1 |
| Class 2 | 0.21 to 2.00 | 1501 to 10,000 | 0.45 | Class 2 |
| Class 3 | 2.01 or greater | 10,001 or greater | 0.40 | Class 3 |

Based on our test results and PCA and CDOT guidelines, all concrete exposed to site soils should use sulfate-resistant cement conforming to one of the following requirements:

Class 0 (Negligible)

- 1) ASTM C150 Type I, II, III, or V.
- 2) ASTM C595 Type IL, IP, IP(MS), IP(HS), or IT.

The contractor should be aware that certain concrete mix components affecting sulfate resistance including, but not limited to, the cement, entrained air, and fly ash, can affect workability, set time, and other characteristics during placement, finishing and curing. The contractor should develop mix(es) for use in project concrete which are suitable with regard to these construction factors, as well as sulfate resistance. A reduced, but still significant, sulfate resistance may be acceptable to the owner, in exchange for desired construction characteristics.

SOIL CORROSIVITY

The degree of risk for corrosion of metals in soils commonly is considered to be in two categories: corrosion in undisturbed soils and corrosion in disturbed soils. The potential for corrosion in undisturbed soil is generally low, regardless of soil types and conditions, because it is limited by the amount of oxygen that is available to create an electrolytic cell. In disturbed soils, the potential for corrosion typically is higher, but is strongly affected by soil chemistry and other factors.

A preliminary corrosivity analysis was performed to provide a general assessment of the potential for corrosion of ferrous metals installed in contact with earth materials at the site, based on the conditions existing at the time of GROUND's evaluation. Soil chemistry and physical property data including resistivity, pH, reduction-oxidation (redox) potential, and qualitative sulfide content were obtained. Test results are summarized on Table 2.

pH Where pH is less than 4.0, soil serves as an electrolyte; the pH range of about 6.5 to 7.5 indicates soil conditions that are optimum for sulfate reduction. In the pH range above 8.5, soils are generally high in dissolved salts, yielding a low soil resistivity (AWWA, 2010). Testing indicated a pH value of approximately 7.4.

Reduction-Oxidation Potential testing indicated a negative potential of approximately -20 millivolts. Such low potentials typically create a more corrosive environment. The redox potential of a soil is significant, because the most common sulfate-reducing bacteria can only live in anaerobic conditions. A negative redox potential indicates anaerobic conditions in which sulfate reducers thrive.

Sulfide Reactivity testing for the presence of sulfides indicated a "trace" result. The presence of sulfides in the site soils also suggests a more corrosive environment. A positive sulfide reaction reveals a potential problem caused by sulfate-reducing bacteria. Anaerobic conditions are regarded as potentially corrosive.

Soil Resistivity In order to assess the "worst case" for mitigation planning, samples of materials retrieved from the test holes were tested for resistivity in the laboratory, after being saturated with water, rather than in the field. Resistivity also varies inversely with temperature. Therefore, the laboratory measurements were made at a controlled

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temperature. A measurement of electrical resistivity indicated a value of approximately 3,162 ohm-centimeters in a selected sample of the site earth materials.

Corrosivity Assessment The American Water Works Association (AWWA, 2010³) has developed a point system scale used to predict corrosivity. The scale is intended for protection of ductile iron pipe but is valuable for project steel selection. When the scale equals 10 points or higher, protective measures for ductile iron pipe are suggested. The AWWA scale (Table A.1 Soil-test Evaluation) is presented below. The soil characteristics refer to the conditions at and above pipe installation depth.

TABLE A.1 SOIL-TEST EVALUATION

| <i>Soil Characteristics</i> | <i>Values</i> | <i>Points</i> |
|---------------------------------------|---------------------------------------|---------------|
| Resistivity (Ω -cm) | < 1,500 | 10 |
| | \geq 1,500 – 1,800 | 8 |
| | > 1,800 – 2,100 | 5 |
| | > 2,100 – 2,500 | 2 |
| | > 2,500 – 3,000 | 1 |
| | > 3,000 | 0 |
| pH | 0 – 2 | 5 |
| | 2 – 4 | 3 |
| | 4 – 6½ | 0 |
| | 6½ – 7½ | 0* |
| | 7½ – 8½ | 0 |
| | > 8½ | 3 |
| Redox Potential (mV) | < 0 | 5 |
| | 0 – 50 | 4 |
| | 50 – 100 | 3½ |
| | > 100 | 0 |
| Sulfides | Positive | 3½ |
| | Trace | 2 |
| | Negative | 0 |
| Moisture | Poor drainage (continuous wet) | 2 |
| | Fair drainage (generally moist) | 1 |
| | Good drainage (generally dry) | 0 |

* If sulfides are present and low or negative redox-potentials results are obtained, add 3 points for this range.

³ American Water Works Association ANSI/AWWA C105/A21.5-05 Standard.

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Based on a maximum possible score of 25½ using the AWWA method, the value of 10 for the use of corrosion protection, and a score of 13 in the tested site soils, the site earth materials appear to comprise a potentially severely corrosive environment for buried metals.

If additional information is needed regarding soil corrosivity, the American Water Works Association or a Corrosion Engineer should be contacted. Corrosion for other project elements should be evaluated in accordance with NCMA, AASHTO, and/or FHWA guidelines based on the results of the corrosivity test results summarized on Table 2. It should be noted, however, that changes to the site conditions during construction, such as the import of other soils, or the intended or unintended introduction of off-site water, may significantly alter corrosion potential.

PROJECT EARTHWORK

The earthwork criteria below are based on our interpretation of the geotechnical conditions encountered in the test holes. Where these criteria differ from applicable municipal specifications, e.g., for trench backfill compaction along a public utility line, the latter should be considered to take precedence.

General Considerations: Site grading should be performed as early as possible in the construction sequence to allow settlement of fills and surcharged ground to be realized to the greatest extent prior to subsequent construction.

Prior to earthwork construction, vegetation and other deleterious materials should be removed and disposed of off-site. Relic underground utilities should be abandoned in accordance with applicable regulations, removed as necessary, and properly capped.

Topsoil present on-site should not be incorporated into ordinary fills. Instead, topsoil should be stockpiled during initial grading operations for placement in areas to be landscaped or for other approved uses.

Use of Existing Fill Soils Fill materials were recognized in the test holes during subsurface exploration and are likely are present elsewhere on the site. Because not all the fill soils were sampled and tested, it is possible that some of the fill soils may not be suitable for re-use as compacted fill, due to the presence of deleterious materials such as

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trash, organic material, coarse cobbles and boulders, or construction debris. Therefore, excavated fill materials should be evaluated and tested, as appropriate, with regard to re-use. Environmental evaluation of the existing fill soil was not part of our scope of services, and should an environmental assessment of the site fill soils be needed, an environmental consultant should be retained.

Fragments of rock and cobbles, (as well as inert construction debris, e.g., concrete or asphalt) up to **3 inches** in maximum dimension may be included in project fills, in general. Such materials should be evaluated on a case-by-case basis, where identified during earthwork.

Use of Existing Native Soils: Overburden soils are suitable, in general, for placement as compacted fill. Organic materials should not be incorporated into project fills.

Fragments of rock and cobbles larger than 3 inches in maximum dimension will require special handling and/or placement to be incorporated into project fills. Such fragments should not consist of non-durable sedimentary bedrock materials (i.e., siltstone, claystone, or sandstone bedrock). In general, such materials should be placed as deeply as possible in the project fills. A Geotechnical Engineer should be consulted regarding appropriate guidance for usage of such materials on a case-by-case basis when such materials have been identified during earthwork. Standard recommendations that likely will be generally applicable can be found in Section 203 of the current CDOT Standard Specifications for Road and Bridge Construction.

Imported Fill Materials: If it is necessary to import material to the site, the imported soils should be free of organic material, and other deleterious materials. **Imported material should consist of soils that have less than 55 percent passing the No. 200 Sieve and should have a plasticity index less than 15.** Representative samples of the materials proposed for import should be tested and approved prior to transport to the site.

Fill Platform Preparation: Prior to filling, the top 8 to 12 inches of in-place materials on which fill soils will be placed should be scarified, moisture conditioned and properly compacted in accordance with the parameters below to provide a uniform base for fill placement. *If over-excavation is to be performed, then these parameters for subgrade preparation are also for the subgrade **below the bottom** of the specified over-excavation depth.*

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If surfaces to receive fill expose loose, wet, soft or otherwise deleterious material, additional material should be excavated, or other measures taken to establish a firm platform for filling. The surfaces to receive fill must be effectively stable prior to placement of fill.

GROUND's experience within the project area suggests the frost depth to be approximately 3 feet, below ground surface.

Fill Placement: Fill materials should be thoroughly mixed to achieve a uniform moisture content, placed in uniform lifts not exceeding 8 inches in loose thickness, and properly compacted.

Soils that classify as ML, MH, CL or CH in accordance with the USCS classification system (cohesive materials) should be compacted to **95 percent** of the maximum dry density at moisture contents **from the optimum moisture content to 3 percent above the optimum moisture content** as determined by ASTM D698.

Soils that classify as GP, GW, GM, GC, SP, SW, SM, or SC in accordance with the USCS classification system (granular materials) should be compacted to **95 or more percent** of the maximum modified Proctor dry density at moisture contents **within 2 percent of optimum moisture content** as determined by ASTM D1557.

No fill materials should be placed, worked, or rolled while they are frozen, thawing, or during poor/inclement weather conditions.

Care should be taken with regard to achieving and maintaining proper moisture contents during placement and compaction. Materials that are not properly moisture conditioned may exhibit significant pumping, rutting, and deflection at moisture contents near optimum and above. The contractor should be prepared to handle soils of this type, including the use of chemical stabilization, if necessary.

Compaction areas should be kept separate, and no lift should be covered by another until relative compaction and moisture content within the suggested ranges are obtained.

Use of Squeegee: Relatively uniformly graded fine gravel or coarse sand, i.e., "squeegee," or similar materials commonly are proposed for backfilling foundation excavations, utility trenches (excluding approved pipe bedding), and other areas where

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employing compaction equipment is difficult. In general, GROUND does not suggest this procedure for the following reasons:

Although commonly considered “self-compacting,” uniformly graded granular materials require densification after placement, typically by vibration. The equipment to densify these materials is not available on many job-sites.

Even when properly densified, granular materials are permeable and allow water to reach and collect in the lower portions of the excavations backfilled with those materials. This leads to wetting of the underlying soils and resultant potential loss of bearing support as well as increased local heave or settlement.

It is GROUND’s opinion that wherever possible, excavations be backfilled with approved, on-site soils placed as properly compacted fill. Where this is not feasible, use of “Controlled Low Strength Material” (CLSM), i.e., a lean, sand-cement slurry (“flowable fill”) or a similar material for backfilling should be considered.

Where “squeegee” or similar materials are proposed for use by the contractor, the design team should be notified by means of a Request for Information (RFI), so that the proposed use can be considered on a case-by-case basis. Where “squeegee” meets the project requirements for pipe bedding material, however, it is acceptable for that use.

Settlements: Settlements will occur in filled ground, typically on the order of 1 to 2 percent of the fill depth. If fill placement is performed properly and is tightly controlled, in GROUND’s experience the majority (on the order of 60 to 80 percent) of that settlement will typically take place during earthwork construction, provided the contractor achieves the compaction levels herein. The remaining potential settlements likely will take several months or longer to be realized, and may be exacerbated if these fills are subjected to changes in moisture content.

Cut and Filled Slopes: Permanent site slopes supported by on-site soils up to 10 feet in height may be constructed no steeper than 3:1 (horizontal : vertical). Minor raveling or surficial sloughing should be anticipated on slopes cut at this angle until vegetation is well re-established. Surface drainage should be designed to direct water away from slope faces.

EXCAVATION CONSIDERATIONS

Excavation Difficulty: The test holes were excavated to the depths indicated by means of conventional, truck-mounted geotechnical drilling equipment. Fill was encountered in the test holes during our exploration program. Although not obviously encountered at the time of drilling, construction debris, such as concrete, asphalt, rebar, etc., should be anticipated to exist within the fill materials. The contractor should be prepared to handle these large and potentially awkward materials. We anticipate no significant excavation difficulties in the majority of the site with conventional heavy-duty excavation equipment in good working condition.

Groundwater: Groundwater was encountered in the test holes at depths ranging from 23 to 29 feet below existing grades at the time of drilling. Water was measured in Test Hole 3 approximately 6 hours after drilling at a depth of approximately 23 feet below existing grade where initially noted at a depth of 29 feet below existing grade. The test holes were backfilled upon drilling operation completion per Code of Colorado Regulations (2 CCR 402-2). Groundwater levels can be expected to fluctuate, however, in response to annual and longer-term cycles of precipitation, irrigation, surface drainage, nearby rivers and creeks, land use, and the development of transient, perched water conditions. The magnitude of these fluctuations will be largely dependent upon the stormwater drainage infrastructure near the site, as well as other canals and nearby streams. The amount of spring snowmelt, duration and intensity of precipitation, irrigation infiltration, and the subsurface and surface drainage characteristics of the draining area will also impact these fluctuations. The groundwater observations performed during our exploration must be interpreted carefully as they are short-term and do not comprise a groundwater study. In the event the Client desires additional/repeated groundwater level observations, GROUND should be contacted; additional exploration and fees will be necessary in this regard.

It is possible that groundwater may be encountered in project excavations at depths both shallower and deeper than those indicated above. The contractor should be prepared to dewater the excavation during construction. Pumps adequate to discharge water and/or well points to draw down the water level may be appropriate methods. Other methods may also be necessary. The dewatering approach should ultimately be determined by the contractor based on their means and methods experience. Dewatering operations may

be necessary as both temporary and long-term/permanent installations. If seepage or groundwater is encountered during excavation or at any time during construction, the Geotechnical Engineer and project team should be contacted to evaluate the conditions. The presence of groundwater in these types of situations and associated potential design changes can have an impact to both the financial and schedule components of a project.

Temporary Excavations and Personnel Safety: Excavations in which personnel will be working must comply with all applicable OSHA Standards and Regulations, particularly CFR 29 Part 1926, OSHA Standards-Excavations, adopted March 5, 1990. The contractor's "responsible person" should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. GROUND has provided the information in this report solely as a service to the Client and is not assuming responsibility for construction site safety or the contractor's activities.

The contractor should take care when making excavations not to compromise the bearing or lateral support for any adjacent, existing improvements.

Should site constraints prohibit the use of the slope angles, temporary shoring should be used. The shoring should be designed to resist the lateral earth pressure exerted by buildings, improvements, traffic, equipment, stockpiles, etc.

Surface Water: The contractor should take pro-active measures to control surface waters during construction and maintain good surface drainage conditions to direct waters away from excavations and into proper drainage structures. A properly designed drainage swale should be provided at the top of the excavations. In no case should water be allowed to pond at the site. Slopes should also be protected against erosion. Erosion along the slopes will result in sloughing and could lead to a slope failure.

UTILITY PIPE INSTALLATION AND BACKFILLING

The measures and criteria below are based on GROUND's evaluation of the local geotechnical conditions. Where the parameters herein differ from applicable municipal requirements, the latter should be considered to govern.

Pipe Support: The bearing capacity of the site soils appeared adequate, in general, for support of typical utility lines. The pipe + contents are anticipated to be less dense than

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the soils which will be displaced for installation. Therefore, in general GROUND anticipates no significant pipe settlements in these materials where properly bedded from loading alone.

Excavation bottoms may expose existing fill soils, soft, loose or otherwise deleterious materials. Firm materials may be disturbed by the excavation process. All such unsuitable materials should be excavated and replaced with properly compacted fill. Areas allowed to pond water will require excavation and replacement with properly compacted fill. The contractor should take particular care to ensure adequate support near pipe joints which are less tolerant of extensional strains.

Where thrust blocks are needed, the parameters in the *Lateral Earth Pressures* section of this report may be used for design.

Trench Backfilling: Some settlement of compacted soil trench backfill materials should be anticipated, even where all the backfill is placed and compacted correctly. Typical settlements are on the order of 1 to 2 percent of fill thickness. However, the need to compact to the lowest portion of the backfill must be balanced against the need to protect the pipe from damage from the compaction process. Some thickness of backfill may need to be placed at compaction levels lower than specified (or smaller compaction equipment used together with thinner lifts) to avoid damaging the pipe. Protecting the pipe in this manner can result in somewhat greater surface settlements. Therefore, although other alternatives may be available, the following options are presented for consideration:

Controlled Low Strength Material: Because of these limitations, we suggest backfilling the entire depth of the trench (both bedding and common backfill zones) with “controlled low strength material” (CLSM), i.e., a lean, sand-cement slurry, “flowable fill,” or similar material along all trench alignment reaches with low tolerances for surface settlements.

CLSM used as pipe bedding and trench backfill exhibit a 28-day unconfined compressive strength between 50 to 200 psi so that re-excavation is not unusually difficult.

Placement of the CLSM in several lifts or other measures likely will be necessary to avoid ‘floating’ the pipe. Measures also should be taken to maintain pipe alignment during CLSM placement.

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Compacted Soil Backfilling: In areas that are tolerant of surface settlements, conventional soil backfilling may be used. Where compacted soil backfilling is employed, using the site soils or similar materials as backfill, the risk of backfill settlements entailed in the selection of this higher risk alternative must be anticipated and accepted by the Client/Owner.

We anticipate that the on-site soils excavated from trenches will be suitable, in general, for use as common trench backfill within the above-described limitations. Backfill soils should be free of vegetation, organic debris and other deleterious materials. Fragments of rock, cobbles, and inert construction debris (e.g., concrete or asphalt) coarser than 3 inches in maximum dimension should not be incorporated into trench backfills.

Soils placed for compaction as trench backfill should be conditioned to a relatively uniform moisture content, placed and compacted in accordance with the *Project Earthwork* section of this report.

Pipe Bedding: Pipe bedding materials, placement and compaction should meet the specifications of the pipe manufacturer and applicable municipal standards. Bedding should be brought up uniformly on both sides of the pipe to reduce differential loadings.

As discussed above, we suggest the use of CLSM or similar material in lieu of granular bedding and compacted soil backfill where the tolerance for surface settlement is low. (Placement of CLSM as bedding to at least 12 inches above the pipe can protect the pipe and assist construction of a well-compacted conventional backfill although possibly at an increased cost relative to the use of conventional bedding.)

If a granular bedding material is specified, it is our opinion that with regard to potential migration of fines into the pipe bedding, design and installation follow ASTM D2321. If the granular bedding does not meet filter criteria for the enclosing soils, then non-woven filter fabric (e.g., Mirafi® 140N, or the equivalent) should be placed around the bedding to reduce migration of fines into the bedding which can result in severe, local surface settlements. Where this protection is not provided, settlements can develop/continue several months or years after completion of the project. In addition, clay or concrete cut-off walls should be installed to interrupt the granular bedding section to reduce the rates and volumes of water transmitted along the sewer alignment which can contribute to migration of fines.

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Additionally, if granular bedding is specified, the contractor should not anticipate that significant volumes of on-site soils will be suitable for that use. Materials proposed for use as pipe bedding should be tested by a geotechnical engineer for suitability prior to use. Imported materials should be tested and approved by a geotechnical engineer prior to transport to the site.

SURFACE DRAINAGE

The site soils are relatively stable with regard to moisture content – volume relationships at their existing moisture contents. Other than the anticipated, post-placement settlement of fills, post-construction soil movement will result primarily from the introduction of water into the soil underlying the proposed structure, hardscaping, and pavements. Based on the site surface and subsurface conditions encountered in this study, we do not anticipate a rise in the local water table sufficient to approach foundation or floor elevations. Therefore, wetting of the site soils likely will result from infiltrating surface waters (precipitation, irrigation, etc.), and water flowing along constructed pathways such as bedding in utility pipe trenches.

The following drainage measures should be incorporated as part of project design and during construction. The facility should be observed periodically to evaluate the surface drainage and identify areas where drainage is ineffective. Routine maintenance of site drainage should be undertaken throughout the design life of the proposed facility. If these measures are not implemented and maintained effectively, the movement estimates provided in this report could be exceeded.

- 1) Wetting or drying of the foundation excavations and underslab areas should be avoided during and after construction as well as throughout the improvements' design life. Permitting increases/variations in moisture to the adjacent or supporting soils may result in a decrease in bearing capacity, an increase in volume change of the underlying soils, and increased total and/or differential movements.

- 2) Measures for positive surface drainage away from the building should be provided and maintained to reduce water infiltration into foundation soils. Underdrains should not be relied upon in surface drainage design to collect and discharge surface waters.

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A minimum slope of **10 percent in the first 10 feet** should be incorporated in the areas not covered with pavement or concrete slabs. For areas covered with pavement or concrete slabs, utilizing slopes of a minimum of **3 percent in the first 10 feet** will reduce, but not eliminate, the potential for moisture infiltration and subsequent volume change of underlying soils. Reducing the slopes to comply with ADA requirements may be necessary by other design professionals but may entail an increased potential for moisture infiltration and subsequent volume change of the underlying soils and resultant distress.

In no case should water be allowed to pond near or adjacent to foundation elements, hardscaping, utility trench alignments, etc.

- 3) Drainage should be established and maintained to direct water away from sidewalks and other hardscaping as well as utility trench alignments. Where the ground surface does not convey water away readily, additional post-construction movements and distress should be anticipated.

The ground surface near foundation elements should be able to convey water away readily.

- 4) In GROUND's experience, it is common during construction that in areas of partially completed paving or hardscaping, bare soil behind curbs and gutters, and utility trenches, water is allowed to pond after rain or snow-melt events. Wetting of the subgrade can result in loss of subgrade support and increased settlements / increased heave. By the time final grading has been completed, significant volumes of water can already have entered the subgrade, leading to subsequent distress and failures. The contractor should maintain effective site drainage throughout construction so that water is directed into appropriate drainage structures.
- 5) On some sites, slopes may descend toward buildings locally. Such slopes can be created during grading even on comparatively flat sites. In such cases, even where the slopes as described above are implemented effectively, water may flow toward and beneath a structure or other site improvements with resultant additional, post-construction movements. Where the final site configuration includes graded or retained slopes descending toward the improvements, surface

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drainage swales and/or interceptor drains should be installed between the improvements and the slope.

Where irrigation is applied on or above slopes, drainage structures commonly are needed near the toe-of-slope to prevent on-going or recurrent wet conditions.

- 6) Roof downspouts and drains, if used, should discharge well beyond the perimeter of the structure foundations (minimum 10 feet) and backfill zones and be provided with positive conveyance off-site for collected waters. Downspouts should not be routed to discharge into an underdrain system.

If roof downspouts and drains are not used, then surface drainage design should anticipate concentrated volumes of water adjacent to the building.

- 7) Based on our experience with similar facilities, the project may include landscaping/watering near site improvements. Irrigation water – both that applied to landscaped areas and over-spray – is a significant cause of distress to improvements.

To reduce the potential for such distress, vegetation requiring watering should be located **10 or more feet** from the building perimeter, flatwork, or other improvements. Irrigation sprinkler heads should be deployed so that applied water is not introduced near or into foundation/subgrade soils. Landscape irrigation should be limited to the minimum quantities necessary to sustain healthy plant growth.

Use of drip irrigation systems can be beneficial for reducing over-spray beyond planters. Drip irrigation can also be beneficial for reducing the amounts of water introduced to foundation/subgrade soils, but only if the total volumes of applied water are controlled with regard to limiting that introduction. Controlling rates of moisture increase beneath the foundations, floors, and other improvements should take higher priority than minimizing landscape plant losses.

Where plantings are desired within 10 feet of a building, plants should be placed in water-tight planters, constructed either in-ground or above-grade, to reduce moisture infiltration in the surrounding subgrade soils. As an alternative involving

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a limited increase in risk, the use of water-tight planters may be replaced by local shallow underdrains beneath the planter beds. Colorado Geological Survey – Special Publication 43 provides additional guidelines for landscaping and reducing the amount of water that infiltrates into the ground.

GROUND understands many municipalities require landscaping within 10 feet of building perimeters. Provided that positive, effective surface drainage is initially implemented and maintained throughout the life of the facility and the Owner understands and accepts the risks associated with this requirement, vegetation that requires little to no watering may be located within 10 feet of the building perimeter.

Inspections must be made by facility representatives to make sure that the landscape irrigation is functioning properly throughout operation and that excess moisture is not applied.

- 8) Plastic membranes should not be used to cover the ground surface adjacent to the building without careful consideration of other components of project drainage. Plastic membranes can be beneficial to directing surface waters away from the building and toward drainage structures; however, they effectively preclude evaporation and transpiration of shallow soil moisture. Therefore, soil moisture tends to increase beneath these membranes. Perforated “weed barrier” membranes that allow ready evaporation from the underlying soils may be used.

Cobbles or other materials that tend to act as baffles and restrict surface flow should not be used to cover the ground surface near the foundations.

- 9) Maintenance as described herein may include complete removal and replacement of site improvements in order to maintain effective surface drainage.
- 10) Detention ponds are often incorporated with project designs. When a detention pond fills, the rate of release of the water is controlled and water is retained in the pond for a period of time. Where in-ground storm sewers direct surface water to the pond, the granular pipe bedding also can direct shallow groundwater or infiltrating surface water toward the pond. Thus, detention ponds can become locations of enhanced and concentrated infiltration into the subsurface, leading to

wetting of foundation soils in the vicinity with consequent heave or settlement. Therefore, unless the pond is clearly down-gradient from the proposed buildings and other structures that would be adversely affected by wetting of the subgrade soils, including off-site improvements, GROUND suggests that the detention pond should be provided with an effective, low permeability liner. In addition, cut-off walls and/or drainage provisions should be provided for the bedding materials surrounding storm sewer lines flowing to the pond.

SUBSURFACE DRAINAGE

As a component of project civil design, properly functioning, subsurface drain systems (underdrains) can be beneficial for collecting and discharging saturated subsurface waters. Underdrains will not collect water infiltrating under unsaturated (vadose) conditions, or moving via capillarity, however. In addition, if not properly constructed and maintained, underdrains can transfer water into foundation soils, rather than remove it. This will tend to induce heave or settlement of the subsurface soils, and may result in distress. Underdrains can, however, provide an added level of protection against relatively severe post-construction movements by draining saturated conditions near individual structures should they arise, and limiting the volume of wetted soil.

Although inclusion of an underdrain system is common on commercial sites like the subject facility, professional opinion varies regarding the potential benefits relative to the cost. It is GROUND's opinion that it will be beneficial to include a perimeter underdrain system to help limit wetting of the foundation bearing soils especially if an underdrain system exists around the existing building; however, we understand that the Client/Owner and project team may consider the reduction of risk provided by a properly constructed and maintained underdrain system does not justify the costs associated with including an underdrain. In such a case, an underdrain system can be excluded. If an underdrain system is excluded, then there will be an increased risk of the post-construction movements estimated in this report being exceeded. GROUND considers this risk to be low, but it is not zero. Where an underdrain system is excluded, extra care should be taken to establish and maintain effective surface drainage, identify and repair wet utility leaks in a timely manner, seal open cracks, joints, and restore effective surface drainage as necessary to limit the volume of water infiltrating the site.

If, however, below-grade or partially below-grade level(s) are added to the building, then we recommend that an underdrain system be included. Damp-proofing should be applied to the exteriors of below-grade elements. The provision of Tencate MiraFi® G-Series backing (or comparable wall drain provisions) on the exteriors of (some) below-grade elements may be appropriate, depending on the intended use. If a (partially) below-grade level is limited in extent, the underdrain system, etc., may be local to that area.

Geotechnical Parameters for Underdrain Design: Where an underdrain system is included in project drainage design, it should be designed in accordance with the recommendations below. The actual underdrain layout, outlets, and locations should be developed by a civil engineer. A typical perimeter underdrain detail can be provided upon request.

An underdrain system should be tested by the contractor after installation and after placement and compaction of the overlying backfill to verify that the system functions properly.

- 1) An underdrain system for a building should consist of perforated, rigid, PVC collection pipe at least 4 inches in diameter, non-perforated, rigid, PVC discharge pipe at least 4 inches in diameter, free-draining gravel, and filter fabric, as well as a waterproof membrane.
- 2) The free-draining gravel should be naturally occurring (not recycled) material with less than 5 percent passing the No. 200 Sieve, more than 50 percent retained on the No. 4 Sieve, and have a maximum particle size of 2 inches. Each collection pipe should be surrounded on the sides and top (only) with 6 or more inches of free-draining gravel.
- 3) The gravel surrounding the collection pipe(s) should be wrapped with filter fabric (MiraFi 140N® or the equivalent) to reduce the migration of fines into the drain system.
- 4) The waterproof membrane should underlie the gravel and pipe, and be attached to the foundation grade beam or stem wall.

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- 5) The underdrain system should be designed to discharge at least 10 gallons per minute of collected water.
- 6) The high point(s) for the collection pipe flow lines should be below the grade beam or shallow foundation bearing elevation. Multiple high points can be beneficial to reducing the depths to which the system would be installed.

The collection and discharge pipe for the underdrain system should be laid on a slope sufficient for effective drainage, but a minimum of 1 percent. (Flatter gradients may be used but will convey water less efficiently and entail an increased risk of local post-construction movements.)

Pipe gradients also should be designed to accommodate at least 1 inch of differential movement after installation along a 50-foot run.

- 7) Underdrain 'clean-outs' should be provided at intervals of no more than 100 feet to facilitate maintenance of the underdrains. Clean-outs also should be provided at collection and discharge pipe elbows of 60 degrees or more.
- 8) The underdrain discharge pipes should be connected to one or more sumps from which water can be removed by pumping, or to outlet(s) for gravity discharge. We suggest that collected waters be discharged directly into the storm sewer system, if possible.

FIRE LANE PAVEMENT SECTIONS

A pavement section is a layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the pavement structure is directly related to the physical properties of the subgrade soils and traffic loadings. The standard care of practice in pavement design describes the flexible pavement section as a "20-year" design pavement; however, most flexible pavements will not remain in satisfactory condition without routine maintenance and rehabilitation procedures performed throughout the life of the pavement. Pavement designs for the private pavements were developed in general accordance with the design guidelines and procedures of the American Association of State Highway and Transportation Officials (AASHTO), Town of Castle Rock Transportation Design Criteria,

and Municipal Government Pavement Engineers Council (MGPEC) with references to the Colorado Department of Transportation (CDOT).

Subgrade Materials: Based on the results of our field exploration and laboratory testing, the potential pavement subgrade materials classify as A-2-4 to A-7-6 soils in accordance with the American Association of State Highway and Transportation Officials (AASHTO) classification system.

Based on our experience with similar projects, a resilient modulus value of 3,562 psi was estimated for the on-site materials. It is important to note that significant decreases in soil support have been observed as the moisture content increases above the optimum. Pavements that are not properly drained may experience a loss of the soil support and subsequent reduction in pavement life.

Anticipated Traffic: Traffic data for the proposed facility was unavailable at the time of our report preparation. Based on our experience with similar projects, an equivalent 18-kip daily load application (EDLA) value of 30 was assumed for the fire lane. The EDLA value was converted to equivalent 18-kip single axle load (ESAL) value of 219,000 for a 20-year design life. If anticipated traffic loadings differ significantly from these assumed values, GROUND should be notified to re-evaluate the pavement sections below.

Pavement Design

The estimated soil resilient modulus and the ESAL values were used to determine the required design structural number for the project pavements. The required structural number was then used to develop the pavement sections. Pavement designs were based on the DARWin™ computer program that solves the 1993 AASHTO pavement design equations. A reliability level of 85 percent and a terminal serviceability of 2 were utilized for design of the pavement sections. A structural coefficient of 0.44 was used for hot bituminous asphalt and 0.12 was used for aggregate base course. The minimum pavement sections for a 20-year design are tabulated below.

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MINIMUM PAVEMENT SECTIONS

| Location | Composite Section <i>(inches Asphalt / inches Aggregate Base)</i> | Rigid Section <i>(inches Concrete / inches Aggregate Base)</i> |
|-----------------|---|--|
| Fire Lane | 5 / 10 | 7 / 6 |

In our experience, asphalt pavements will not perform as well as rigid pavement in areas of high turning stresses or prolonged static loading, and additional maintenance costs (repairing of tearing and pushing distress) should be anticipated if either of these sections were selected.

Pavement Properties

Hot-Mix Asphalt (HMA): The asphalt pavement shall consist of a bituminous plant mix composed of a mixture of high-quality aggregate and bituminous material. Asphalt mixture(s) should meet the requirements of a job-mix formula established by a qualified engineer.

Portland Cement Concrete Pavement (PCCP): Concrete pavements should consist of a plant mix composed of a mixture of aggregate, Portland cement, and appropriate admixtures meeting the requirements of a job-mix formula established by a qualified engineer. Concrete should have a minimum modulus of rupture of third point loading of 650 psi. Normally, concrete with a 28-day compressive strength of 4,000 psi should develop this modulus of rupture value. The concrete should be air-entrained with approximately 6 percent air and should have a minimum cement content of 6 sacks per cubic yard. Maximum allowable slump should be 4 inches.

These concrete mix design criteria should be coordinated with other project requirements including any criteria for sulfate resistance presented in the *Water-Soluble Sulfates* section of this report. To reduce surficial spalling resulting from freeze-thaw cycling, we suggest that pavement concrete meet the requirements of CDOT Class P concrete. In addition, the use of de-icing salts on concrete pavements during the first winter after construction will increase the likelihood of the development of scaling. Placement of flatwork concrete during cold weather so that it is exposed to freeze-thaw cycling before it is fully cured also increases its vulnerability to scaling. Concrete placing during cold weather conditions

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should be blanketed or tented to allow full curing. Depending on the weather conditions, this may result in 3 to 4 weeks of curing, and possibly more.

Concrete pavements should contain sawed or formed joints. CDOT and various industry groups provide guidelines for proper design and concrete construction and associated jointing. In areas of repeated turning stresses, such as truck loading and unloading areas, the concrete pavement joints should be fully tied and doweled. Example layouts for joints, as well as ties and dowels, which may be applicable, can be found in CDOT's M standards, found at the CDOT website: PCA, ACI, and ACPA publications also provide useful guidance in these regards. Joint spacings less than the 15-foot maximum indicated in in CDOT's M standards, e.g., 10 feet or 12 feet, may be beneficial to reduce concrete cracking.

Aggregate Base Course: The aggregate base course material should meet the criteria of CDOT Class 5 or Class 6 Aggregate Base Course. Base course should be placed in uniform lifts not exceeding 8 inches in loose thickness and compacted to at least 95 percent of the maximum dry density a uniform moisture contents within 2 percent of the optimum as determined by ASTM D1557 / AASHTO T-180, the "modified Proctor." Base course should be extended for a distance of 1 foot behind the back face of the curb, where applicable.

Subgrade Preparation: Remedial earthwork to any depth will not prevent pavement distress on these soils, but will tend to reduce it and improve perceived rideability. If performance like project floors is desired, then project pavements should be constructed in a similar manner as project floors.

Remedial Earthwork Where undocumented fill soils are present (see *Site Conditions*), all of the existing fill soils should be removed and replaced in a controlled manner. The pavements should be constructed on a section of properly moisture-conditioned and compacted soils to a depth of **at least 12 inches**. These sections assume that a) traffic speeds in the parking areas and driveways will be relatively slow, and b) the facility owner will be tolerant of significant total and differential pavement post-construction movements (on the order of several inches) and the associated maintenance costs that that are necessary to re-establish effective drainage, replace distressed pavement, etc.

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Subgrade preparation of the selected depth should extend the full width of the pavement from back-of-curb to back-of-curb. The subgrade for any sidewalks and other project hardscaping also should be prepared in the same manner.

Geotechnical criteria for fill placement and compaction are provided in the *Project Earthwork* section of this report. The contractor should be prepared to either dry the subgrade materials or moisten them, as needed, prior to compaction.

Proof Rolling Immediately prior to paving, the subgrade should be proof rolled with a heavily loaded, pneumatic tired vehicle. Areas that show excessive deflection during proof rolling should be excavated and replaced and/or stabilized. Areas allowed to pond prior to paving will require significant re-working prior to proof-rolling. *Establishment of a firm paving platform (as indicated by proof rolling) is an additional requirement beyond proper fill placement and compaction.* It is possible for soils to be compacted within the limits indicated in the *Project Earthwork* section of this report and fail proof rolling, particularly in the upper range of moisture content.

Additional Observations: The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of the pavements. The subsurface and surface drainage systems should be carefully designed to ensure removal of the water from paved areas and subgrade soils. Allowing surface waters to pond on pavements will cause premature pavement deterioration. Where topography, site constraints, or other factors limit or preclude adequate surface drainage, pavements should be provided with edge drains to reduce loss of subgrade support. The long-term performance of the pavement also can be improved greatly by proper backfilling and compaction behind curbs, gutters, and sidewalks so that ponding is not permitted and water infiltration is reduced.

Landscape irrigation in planters adjacent to pavements and in “island” planters within paved areas should be carefully controlled or differential heave and/or rutting of the nearby pavements will result. Drip irrigation systems are suggested for such planters to reduce over-spray and water infiltration beyond the planters. Enclosing the soil in the planters with plastic liners and providing them with positive drainage also will reduce differential moisture increases in the surrounding subgrade soils. In our experience, infiltration from planters adjacent to pavements is a principal source of moisture increase beneath those

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pavements. This wetting of the subgrade soils from infiltrating irrigation commonly leads to loss of subgrade support for the pavement with resultant accelerating distress, loss of pavement life and increased maintenance costs. This is particularly the case in the later stages of project construction after landscaping has been emplaced but heavy construction traffic has not ended. Heavy vehicle traffic over wetted subgrade commonly results in rutting and pushing of flexible pavements, and cracking of rigid pavements. In relatively flat areas where design drainage gradients necessarily are small, subgrade settlement can obstruct proper drainage and yield increased infiltration, exaggerated distress, etc. (These considerations apply to project flatwork, as well.)

As noted above, the standard care of practice in pavement design most often describes the pavement section as a “20-year” design pavement; however, most pavements will not remain in satisfactory condition without routine, preventive maintenance and rehabilitation procedures performed throughout the life of the pavement. Preventive pavement treatments are surface rehabilitation and operations applied to improve or extend the functional life of a pavement. These treatments preserve, rather than improve, the structural capacity of the pavement structure. In the event the existing pavement is not structurally sound, the preventive maintenance will have no long-lasting effect. Therefore, a routine maintenance program to seal cracks, repair distressed areas, and perform thin overlays throughout the life of the pavement is suggested.

A crack sealing and fog seal/chip seal program should be performed on the pavements every 3 to 4 years. After approximately 8 to 10 years, patching, additional crack sealing, and asphalt overlay may be required. Prior to future overlays, it is important that all transverse and longitudinal cracks be sealed with a flexible, rubberized crack sealant in order to reduce the potential for propagation of the crack through the overlay. Traffic volumes that exceed the values utilized by this report will likely necessitate the need of pavement maintenance practices on a schedule of shorter timeframe than that stated above. The greatest benefit of preventive maintenance is achieved by placing the treatments on sound pavements that have little or no distress.

GROUND’s experience indicates that longitudinal cracking is common in asphalt-pavements generally parallel to the interface between the asphalt and concrete structures such as curbs, gutters or drain pans. Distress of this type is likely to occur even where the subgrade has been prepared properly and the asphalt has been compacted properly.

The use of thick base course or reinforced concrete pavement can reduce this. Our office should be contacted if these alternates are desired.

The assumed traffic loading does not include excess loading conditions imposed by heavy construction vehicles. Consequently, heavily loaded concrete, lumber, and building material trucks can have a detrimental effect on the pavement. An effective program of regular maintenance should be developed and implemented to seal cracks, repair distressed areas, and perform thin overlays throughout the life of the pavements.

EXTERIOR FLATWORK

We understand portions of the site will be provided with concrete flatwork. Like other site improvements, flatwork will experience post-construction movements as soil moisture contents increase after construction and distress likely will result. The following measures will help to reduce damages to these improvements, but will not prevent all movements. Critical flatwork, which may include flatwork at entrances and exits and patios, should be constructed as a reinforced structural slab or slab-on-grade floor in a similar manner to project floors. Areas desired for limited post-construction movements should be structurally supported. Such areas should be identified by the owner.

- 1) Remedial earthwork to prepare flatwork subgrades is subject to the same factors discussed in the *Pavement Sections* section of this report, and should be undertaken to the same depth.
- 2) Prior to placement of flatwork, a proof roll should be performed to identify areas that exhibit instability and deflection. The deleterious soils in these areas should be removed and replaced with properly compacted fill. The contractor should take care to achieve and maintain compaction behind curbs to reduce differential sidewalk settlements. Passing a proof roll is an additional requirement to placing and compacting the subgrade fill soils within the specified ranges of moisture content and relative compaction in the *Project Earthwork* section of this report. Subgrade stabilization may be cost-effective in this regard.
- 3) Flatwork should be provided with control joints extending to an effective depth and spaced no more than **10 feet** apart, both ways. Narrow flatwork, such as sidewalks, likely will require more closely spaced joints.

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Castle Rock, Colorado**

- 4) In no case should exterior flatwork extend to under any portion of the building where there is less than **2 inches** of vertical clearance between the flatwork and any element of the building. Exterior flatwork in contact with brick, rock facades, or any other element of the building can cause damage to the structure if the flatwork experiences movements.

Construction and Drainage Between Buildings and Pavements: Proper design, drainage, construction and maintenance of the areas between individual buildings and parking/driveway areas are critical to the satisfactory performance of the project. Sidewalks, entranceway slabs and roofs, fountains, raised planters and other highly visible improvements commonly are installed within these zones, and distress in or near these improvements is common. Commonly, proper soil preparation in these areas receives little attention during overlot construction because they fall between the building and pavement areas which typically are built with heavy equipment. Subsequent landscaping and hardscape installation often is performed by multiple sub-contractors with light or hand equipment, and necessary over-excavation and soil processing is not performed. Consequently, subgrade soil conditions commonly deviate significantly from specified ranges. Therefore, the contractor should take particular care with regard to proper subgrade preparation in the immediate building exteriors.

Concrete Scaling: Climatic conditions in the project area including relatively low humidity, large temperature changes and repeated freeze – thaw cycles, make it likely that project sidewalks and other exterior concrete will experience surficial scaling or spalling. The likelihood of concrete scaling can be increased by poor workmanship during construction, such as ‘over-finishing’ the surfaces. In addition, the use of de-icing salts on exterior concrete flatwork, particularly during the first winter after construction, will increase the likelihood of scaling. Even use of de-icing salts on nearby roadways, from where vehicle traffic can transfer them to newly placed concrete, can be sufficient to induce scaling. Typical quality control / quality assurance tests that are performed during construction for concrete strength, air content, etc., do not provide information with regard to the properties and conditions that give rise to scaling.

We understand that some municipalities require removal and replacement of concrete that exhibits scaling, even if the material was within specification and placed correctly. The

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contractor should be aware of the local requirements and be prepared to take measures to reduce the potential for scaling and/or replace concrete that scales.

In GROUND's experience, the measures below can be beneficial for reducing the likelihood of concrete scaling. Which measures, if any, used should be based on cost and the owner's tolerance for risk and maintenance. It must be understood, however, that because of the other factors involved, including weather conditions and workmanship, surface damage to concrete can develop, even where all of these measures were followed. Also, the mix design criteria should be coordinated with other project requirements including criteria for sulfate resistance presented in the *Water-Soluble Sulfates* section of this report.

- 1) Maintaining a maximum water/cement ratio of 0.45 by weight for exterior concrete mixes.
- 2) Include Type F fly ash in exterior concrete mixes as 20 percent of the cementitious material.
- 3) Specify a minimum, 28-day, compressive strength of 4,500 psi for all exterior concrete.
- 4) Including 'fibermesh' in the concrete mix also may be beneficial for reducing surficial scaling.
- 5) Cure the concrete effectively at uniform temperature and humidity. This commonly will require fogging, blanketing and/or tenting, depending on the weather conditions. As long as 3 to 4 weeks of curing may be required, and possibly more.
- 6) Avoid placement of concrete during cold weather so that it is not exposed to freeze-thaw cycling before it is fully cured.
- 7) Avoid the use of de-icing salts on given reaches of flatwork through the first winter after construction.

We understand that sometimes it is not practical to implement some of these measures for reducing scaling due to safety considerations, project scheduling, etc. In such cases,

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where these measures are not implemented, additional costs for flatwork maintenance or reconstruction should be incorporated into project budgets.

Frost and Ice Considerations: Nearly all soils other than relatively coarse, clean, granular materials are susceptible to loss of density if allowed to become saturated and exposed to freezing temperatures and repeated freeze – thaw cycling. The formation of ice in the underlying soils can result in heaving of pavements, flatwork, and other hardscaping (“ice jacking”) in sustained cold weather up to 2 inches or more. This heaving can develop relatively rapidly. A portion of this movement typically is recovered when the soils thaw, but due to loss of soil density, some degree of displacement will remain. This can result even where the subgrade soils were prepared properly.

Where hardscape movements are a design concern, e.g., at doorways, replacement of the subgrade soils with 3 or more feet of clean, coarse sand or gravel should be considered or supporting the element on foundations similar to the building and spanning over a void. Detailed guidance in this regard can be provided upon request. It should be noted that where such open graded granular soils are placed, water can infiltrate and accumulate in the subsurface relatively easily, which can lead to increased settlement or heave from factors unrelated to ice formation. Therefore, where a section of open graded granular soils is placed, a local underdrain system should be provided to discharge collected water. GROUND will be available to discuss these concerns upon request.

TEMPORARY FIRE TRUCK ACCESS

Commonly, construction sites are required by local fire departments to provide temporary access for emergency response. It has been GROUND's experience these access drives are to provide support for trucks weighing up to 90,000 pounds and are typically desired to be gravel/aggregate-surfaced.

Based on our experience, a temporary section consisting of at least 12 inches of material meeting the requirements of CDOT Class 5 or Class 6 Aggregate Base Course or at least 8 inches of CDOT Class 5 or Class 6 Aggregate Base Course over a layer of stabilization geotextile/geofabric, such as Mirafi® RS380i or the equivalent, could be utilized provided the Owner understands that this section is for temporary access during construction only and is not a replacement or an equal alternate to the pavement section(s) that was indicated previously. The aggregate base course placed for this purpose should be

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compacted to at least 95 percent of the maximum modified Proctor dry density. It should be noted that the aggregate base course sections indicated above are not intended to support fire truck outriggers without cribbing or similar measures.

It should be understood that with any aggregate surface, shoving and displacement of the granular materials should be expected during repetitive vehicular/equipment loading. Therefore, regular maintenance should be implemented to ensure proper surface and subsurface drainage, repair distressed/damaged areas, and re-establish grades. Application of additional aggregate may be required in this regard. Additionally, the ability of the aggregate temporary access drive to accommodate loads as indicated above is directly related to the quality of the subgrade materials on which the aggregate is placed, not only on the aggregate section. If water infiltrates these areas, additional rutting and other distress, including a reduction in capacity, will result, requiring additional maintenance.

CLOSURE

Geotechnical Review The author of this report or a GROUND principal should be retained to review project plans and specifications to evaluate whether they comply with the intent of the measures discussed in this report. The review should be requested in writing.

The geotechnical conclusions and parameters presented in this report are contingent upon observation and testing of project earthwork by representatives of GROUND. If another geotechnical consultant is selected to provide materials testing, then that consultant must assume all responsibility for the geotechnical aspects of the project by concurring in writing with the parameters in this report, or by providing alternative parameters.

Materials Testing Creekside Bible Church should consider retaining a geotechnical engineer to perform materials testing during construction. The performance of such testing or lack thereof, however, in no way alleviates the burden of the contractor or subcontractor from constructing in a manner that conforms to applicable project documents and industry standards. The contractor or pertinent subcontractor is ultimately responsible for managing the quality of their work; furthermore, testing by the geotechnical engineer does not preclude the contractor from obtaining or providing whatever services

**Creekside Bible Church Expansion
Castle Rock, Colorado**

that he deems necessary to complete the project in accordance with applicable documents.

Limitations This report has been prepared for Creekside Bible Church as it pertains to design of the proposed building addition at Creekside Bible Church in Castle Rock, Colorado, as described herein. It should not be assumed to contain sufficient information for other parties or other purposes. The Client has agreed to the terms, conditions, and liability limitations outlined in our proposal between Creekside Bible Church and GROUND. Reliance upon our report is not granted to any other potential owner, contractor, or lender.

In addition, GROUND has assumed that project construction will commence by summer 2025 and end within 1 year of the project commencement date. Any changes in project plans or schedule should be brought to the attention of a geotechnical engineer, in order that the geotechnical conclusions in this report may be re-evaluated and, as necessary, modified. **If our described understanding/interpretation of the proposed project is incorrect or project elements differ in any way from that expressed herein, including additional buildings/structures, changes to improvement locations, dimensions, structural loading, site improvements, grades, etc., and are incorporated into this project, either after the original information was provided to us or after the date of this report, GROUND must be notified to re-evaluate the conclusions and parameters presented herein.**

The geotechnical conclusions and parameters in this report were based on subsurface information from a limited number of exploration points, as shown in *Figure 1*, as well as the means and methods described herein. Subsurface conditions were interpolated between and extrapolated beyond these locations. It is not possible to guarantee the subsurface conditions are as indicated in this report. Actual conditions exposed during construction may differ from those encountered during site exploration. Design modifications may be necessary by the project team; this may result in an increase in project costs and schedule delays. In addition, a contractor who obtains information from this report for development of their scope of work or cost estimates does so solely at their own risk and may find the geotechnical information in this report to be inadequate for their purposes or find the geotechnical conditions described herein to be at variance with their experience in the greater project area. The contractor should obtain the additional

**Creekside Bible Church Expansion
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geotechnical information that is necessary to develop their workscope and cost estimates with sufficient precision. This includes, but is not limited to, information regarding excavation conditions, earth material usage, current depths to groundwater, etc. Because of the necessarily limited nature of the subsurface exploration performed for this study, the contractor should be allowed to evaluate the site using test pits or other means to obtain additional subsurface information to prepare their bid.

If during construction, surface, soil, bedrock, or groundwater conditions appear to be at variance with those described herein, work should cease and a geotechnical engineer should be retained at once, so that our conclusions and design parameters for this site may be re-evaluated in a timely manner and dependent aspects of project design can be modified, as necessary.

The materials present on-site are stable at their natural moisture content, but may change volume or lose bearing capacity or stability with changes in moisture content. Performance of the proposed structure and pavement will depend on implementation of the conclusions and information in this report and on proper maintenance after construction is completed. Because water is a significant cause of volume change in soils and rock, allowing moisture infiltration may result in movements, some of which will exceed estimates provided herein and should therefore be expected by Creekside Bible Church

ALL DEVELOPMENT CONTAINS INHERENT RISKS. It is important that ALL aspects of this report, as well as the estimated performance (and limitations with any such estimations) of proposed improvements are understood by Creekside Bible Church Utilizing the geotechnical parameters and measures herein for planning, design, and/or construction constitutes understanding and acceptance of the conclusions with regard to risk and other information provided herein, associated improvement performance, as well as the limitations inherent within such estimates. Ensuring correct interpretation of the contents of this report by others is not the responsibility of GROUND. If any information referred to herein is not well understood, it is imperative that Creekside Bible Church contact the author or a GROUND principal immediately. We will be available to meet to discuss the risks and remedial approaches presented in this report, as well as other potential approaches, upon request.

**Creekside Bible Church Expansion
Castle Rock, Colorado**

Current applicable codes may contain criteria regarding performance of structures and/or site improvements which may differ from those provided herein. Our office should be contacted regarding any apparent disparity.

GROUND makes no warranties, either expressed or implied, as to the professional data, opinions or conclusions contained herein. Because of numerous considerations that are beyond GROUND's control, the economic or technical performance of the project cannot be guaranteed in any respect.

This document, together with the concepts and conclusions presented herein, as an instrument of service, is intended only for the specific purpose and Client for which it was prepared. Re-use of, or improper reliance on this document without written authorization and adaption by GROUND Engineering Consultants, Inc., shall be without liability to GROUND Engineering Consultants, Inc.

GROUND appreciates the opportunity to complete this portion of the project and welcomes the opportunity to provide Creekside Bible Church with a proposal for construction observation and materials testing.

Sincerely,

GROUND Engineering Consultants, Inc.


Brian J. Knecht, P.G.



Reviewed by Jason A. Smith, REM, P.E.



GOOGLE EARTH AERIAL IMAGE (09/04/2023)

4



Indicates test hole numbers and approximate locations.



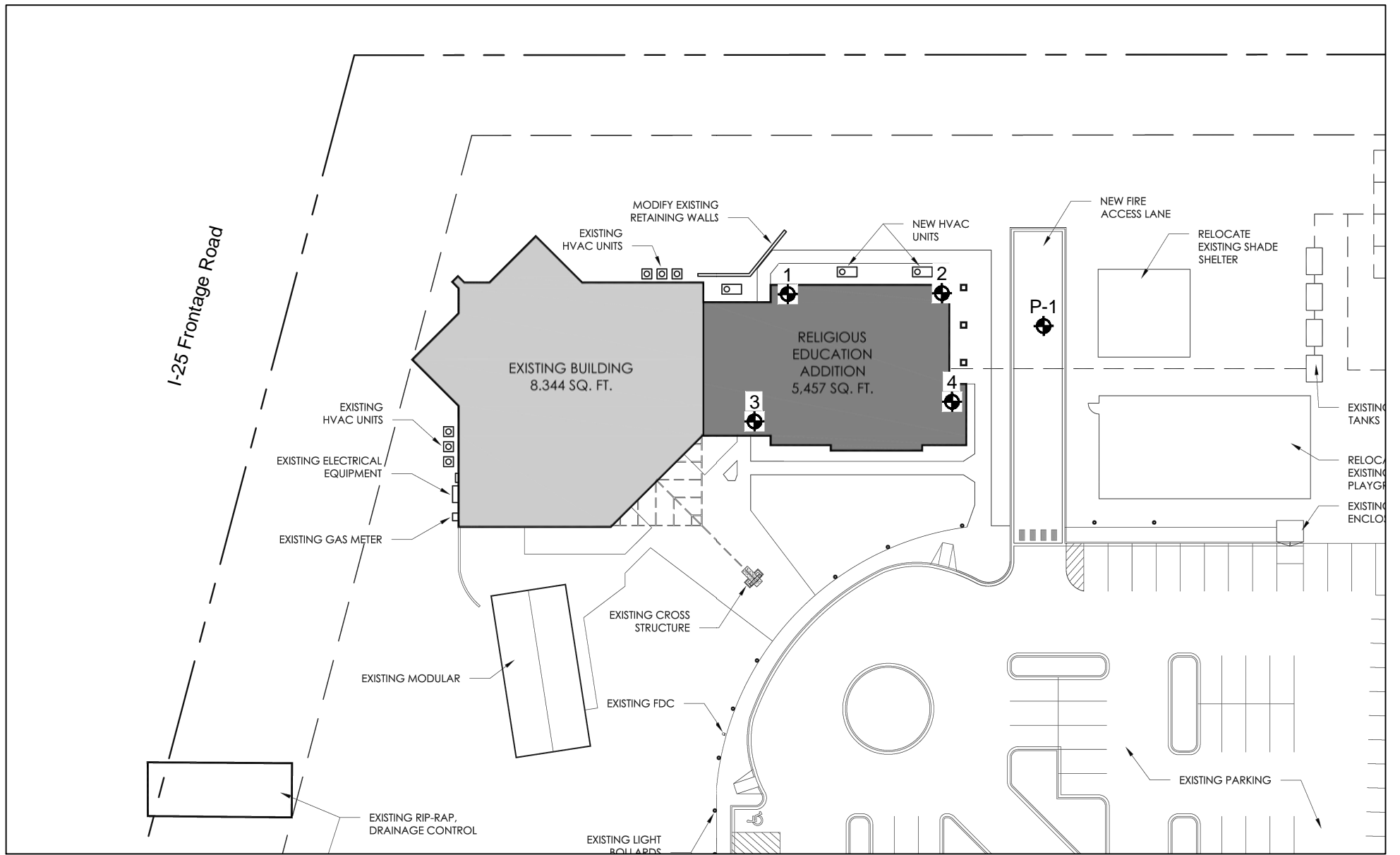
NOT TO SCALE

GROUND
ENGINEERING

JOB NO.: 24-3566

FIGURE: 1A

LOCATION OF TEST HOLES



SITE PLAN PROVIDED BY CLIENT

4
 Ⓢ Indicates test hole numbers and approximate locations.

NOT TO SCALE

| | |
|-------------------------------|------------------|
| GROUND ENGINEERING | JOB NO.: 24-3566 |
| | FIGURE: 1B |
| LOCATION OF TEST HOLES | |

PROJECT: Creekside Bible Church Expansion

JOB NO: 24-3566

CLIENT: Creekside Bible Church

SITE LOCATION: Castle Rock, CO

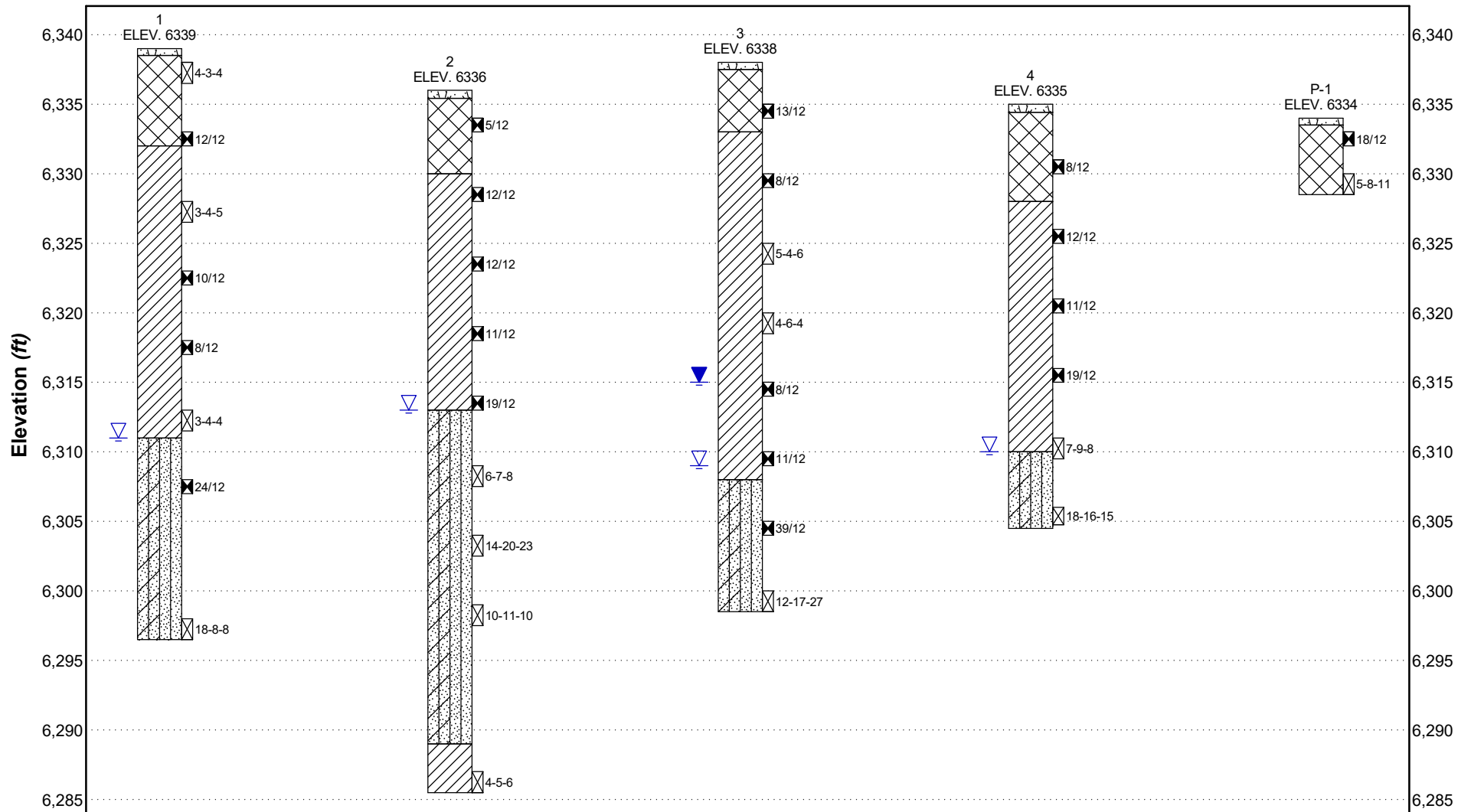


FIGURE: 2

PROJECT: Creekside Bible Church Expansion

JOB NO: 24-3566

CLIENT: Creekside Bible Church

SITE LOCATION: Castle Rock, CO

MATERIAL SYMBOLS



TOPSOIL



FILLS



CLAYS



SANDS

SAMPLER SYMBOLS



Modified California Liner Sampler

23 / 12 Drive sample blow count indicates 23 blows of a 140 pound hammer falling 30 inches were required to drive the sampler 12 inches.



Standard Penetration Test Sampler

20-25-30 Drive sample blow count, indicates 20, 25, and 30 blows of a 140 pound hammer falling 30 inches were required to drive the sampler 18 inches in three 6 inch increments.

NOTES

1. Test holes were drilled on 5/28/2024 with 4" solid stem auger.
2. Locations of the test holes were determined in the field using a hand held GPS device by GROUND.
3. Elevations of test holes were estimated from client provided documents and the logs of test holes are hung to elevation.
4. The test hole locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between materials shown on the test hole logs represent the approximate boundaries between material types and the transitions may be gradual.
6. Groundwater level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water level may occur with time.
7. The material descriptions on these logs are for general classification purposes only. See full text of this report for descriptions of the site materials & related information.
8. All test holes were immediately backfilled upon completion of drilling, unless otherwise specified in this report.

NOTE: See Detailed Logs for Material descriptions.

ABBREVIATIONS

▽ Water Level at Time of Drilling, or as Shown

▽ Water Level at End of Drilling, or as Shown

▽ Water Level After 24 Hours, or as Shown

NV No Value

NP Non-Plastic

Creekside Bible Church Expansion

TABLE 1: SUMMARY OF LABORATORY TEST RESULTS

| Sample Location | | Natural Moisture Content (%) | Natural Dry Density (pcf) | Gradation | | | Atterberg Limits | | Swell/Consolidation | | Unconfined Compressive Strength | | USCS Equivalent Classification | AASHTO Equivalent Classification (Group Index) | Sample Description |
|-----------------|--------------|------------------------------|---------------------------|------------|----------|-----------|------------------|------------------|---------------------|--------------------------|---------------------------------|-------|--------------------------------|--|----------------------|
| Test Hole No. | Depth (feet) | | | Gravel (%) | Sand (%) | Fines (%) | Liquid Limit | Plasticity Index | Volume Change (%) | Surcharge Pressure (psf) | (psi) | (ksf) | | | |
| 1 | 6 | 14.9 | 111.1 | 5 | 50 | 44.8 | 31 | 11 | - | - | - | - | SC | A-6 (2) | FILL: Clayey SAND |
| 1 | 16 | 30.6 | 88.6 | 0 | 8 | 92.3 | 39 | 15 | 0.0 | 2,000 | - | - | CL | A-6 (15) | CLAY |
| 2 | 2 | 9.0 | 119.3 | 12 | 63 | 25.1 | 22 | 4 | - | - | - | - | SM | A-2-4 (0) | FILL: Silty SAND |
| 2 | 7 | - | - | - | - | - | - | - | 0.7 | 875 | - | - | - | - | Sandy CLAY |
| 2 | 12 | 29.8 | - | 0 | 2 | 98.3 | 39 | 16 | 0.2 | 1,500 | - | - | CL | A-6 (17) | CLAY |
| 2 | 17 | - | - | - | - | - | - | - | - | - | 28.4 | 4.09 | - | - | CLAY |
| 3 | 3 | 10.4 | 119.8 | 55 | 10 | 34.6 | 35 | 13 | -0.2 | 375 | - | - | GC | A-2-6 (1) | FILL: Clayey GRAVEL |
| 3 | 8 | 14.5 | 111.1 | 1 | 54 | 45.5 | 32 | 11 | 0.0 | 1,000 | - | - | SC | A-6 (2) | Clayey SAND |
| 3 | 28 | 21.8 | 105.2 | - | - | - | - | - | - | - | 20.8 | 3 | - | - | CLAY |
| 4 | 4 | 11.5 | 120.6 | 9 | 60 | 31.4 | 28 | 8 | -0.3 | 500 | - | - | SC | A-2-4 (0) | FILL: Clayey SAND |
| 4 | 14 | - | - | - | - | - | - | - | 0.0 | 1,750 | - | - | - | - | CLAY |
| 4 | 29 | 14.5 | SD | 14 | 78 | 8.0 | 25 | 8 | - | - | - | - | SP-SC | A-2-4 (0) | SAND with Clay |
| P-1 | 4 | 19.1 | SD | 0 | 17 | 83.2 | 48 | 27 | - | - | - | - | (CL)s | A-7-6 (23) | FILL: CLAY with Sand |

SD = Sample disturbed

Job No. 24-3566

Creekside Bible Church Expansion

TABLE 2: SUMMARY OF SOIL CORROSION TEST RESULTS

| Sample Location | | Water Soluble Sulfates (%) | pH | Redox Potential (mv) | Sulfide Reactivity | Resistivity (ohm-cm) | Sample Description |
|-----------------|--------------|----------------------------|-----|----------------------|--------------------|----------------------|--------------------|
| Test Hole No. | Depth (feet) | | | | | | |
| 1 | 1 | 0.04 | 7.4 | - 20 | Trace | 3,162 | FILL: Sandy CLAY |

Job No. 24-3566

Appendix A

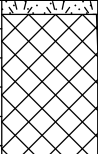

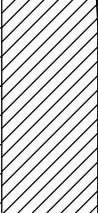

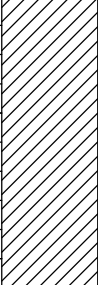

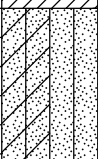
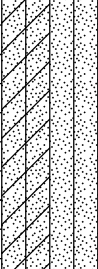
Detailed Logs of the Test Holes

PROJECT: Creekside Bible Church Expansion

JOB NO: 24-3566

CLIENT: Creekside Bible Church

SITE LOCATION: Castle Rock, CO

| Elevation (ft) | Depth (ft) | Graphic Log | Material Descriptions and Drilling Notes | Sample Type | Blow Count | Natural Moisture Content (%) | Natural Dry Density (pcf) | Percent Passing No. 200 Sieve | Atterberg Limits | | Swell/Consolidation (%) at Surcharge Pressure (psf) | Unconfined Compressive Strength (ksf) | USCS Equivalent Classification |
|----------------|------------|---|--|-------------|------------|------------------------------|---------------------------|-------------------------------|------------------|------------------|---|---------------------------------------|--------------------------------|
| | | | | | | | | | Liquid Limit | Plasticity Index | | | |
| 6339 | 0 | | TOPSOIL: Approximately 6 inches of topsoil. | | | | | | | | | | |
| 6334 | 5 |  | FILLS: Clays with sands, clayey to silty sands and gravels. The granular fractions consisted of fine to coarse sands and scattered gravels. They were slightly to highly plastic, slightly moist to moist, and dark brown to gray-brown in color. Iron staining was noted commonly. | X | 4-3-4 | | | | | | | | |
| 6329 | 10 |  | Roots noted in sample at 1 foot. | X | 12/12 | 14.9 | 111.1 | 45 | 31 | 11 | | | SC |
| 6324 | 15 |  | CLAYS: Clays and sandy clays with local clayey to silty sands. The granular fractions consisted of fine sands with scattered medium to coarse sands and gravels. They were slightly to moderately plastic, medium to very stiff / loose to medium dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. Lignite filaments were noted locally. | X | 3-4-5 | | | | | | | | |
| 6319 | 20 |  | | X | 10/12 | 30.6 | 88.6 | 92 | 39 | 15 | 0 (2000) | | CL |
| 6314 | 25 |  | | X | 8/12 | | | | | | | | |
| 6309 | 30 |  | SANDS: Sands with clays and silts and silty to clayey sands with local clays. The granular fractions consisted of fine to coarse sands and gravels. They were slightly plastic, medium dense to dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. | X | 3-4-4 | | | | | | | | |
| 6304 | 35 |  | Groundwater encountered at 28 feet approximately 5 hours after drilling. | X | 24/12 | | | | | | | | |
| 6299 | 40 |  | | X | 18-8-8 | | | | | | | | |

Bottom of test hole at approx. 42.5 feet.

PROJECT: Creekside Bible Church Expansion

JOB NO: 24-3566

CLIENT: Creekside Bible Church

SITE LOCATION: Castle Rock, CO

| Elevation (ft) | Depth (ft) | Graphic Log | Material Descriptions and Drilling Notes | Sample Type | Blow Count | Natural Moisture Content (%) | Natural Dry Density (pcf) | Percent Passing No. 200 Sieve | Atterberg Limits | | Swell/Consolidation (%) at Surcharge Pressure (psf) | Unconfined Compressive Strength (ksf) | USCS Equivalent Classification |
|----------------|------------|-------------|--|-------------|------------|------------------------------|---------------------------|-------------------------------|------------------|------------------|---|---------------------------------------|--------------------------------|
| | | | | | | | | | Liquid Limit | Plasticity Index | | | |
| 6336 | 0 | | TOPSOIL: Approximately 7 inches of topsoil. | | | | | | | | | | |
| 6331 | 5 | | FILLS: Clays with sands, clayey to silty sands and gravels. The granular fractions consisted of fine to coarse sands and scattered gravels. They were slightly to highly plastic, slightly moist to moist, and dark brown to gray-brown in color. Iron staining was noted commonly. | ▲ | 5/12 | 9 | 119.3 | 25 | 22 | 4 | | | SM |
| 6326 | 10 | | CLAYS: Clays and sandy clays with local clayey to silty sands. The granular fractions consisted of fine sands with scattered medium to coarse sands and gravels. They were slightly to moderately plastic, medium to very stiff / loose to medium dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. Lignite filaments were noted locally. | ▲ | 12/12 | | | | | | 0.7 (875) | | |
| 6321 | 15 | | | ▲ | 12/12 | 29.8 | | 98 | 39 | 16 | 0.2 (1500) | | CL |
| 6316 | 20 | | | ▲ | 11/12 | | | | | | | 4.09 | |
| 6311 | 25 | | SANDS: Sands with clays and silts and silty to clayey sands with local clays. The granular fractions consisted of fine to coarse sands and gravels. They were slightly plastic, medium dense to dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. | ▲ | 19/12 | | | | | | | | |
| 6306 | 30 | | Groundwater encountered at 23 feet at the time of drilling. | ⊗ | 6-7-8 | | | | | | | | |
| 6301 | 35 | | | ⊗ | 14-20-23 | | | | | | | | |
| 6296 | 40 | | | ⊗ | 10-11-10 | | | | | | | | |
| 6291 | 45 | | | | | | | | | | | | |
| 6286 | 50 | | CLAYS: Clays and sandy clays with local clayey to silty sands. The granular fractions consisted of fine sands with scattered medium to coarse sands and gravels. They were slightly to moderately plastic, medium to very stiff / loose to medium dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. Lignite filaments were noted locally. | ⊗ | 4-5-6 | | | | | | | | |

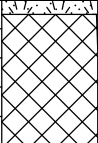
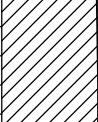
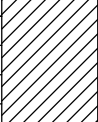
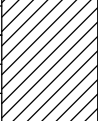
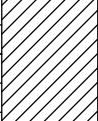
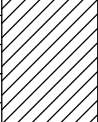
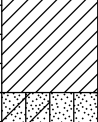
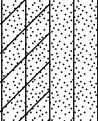
Bottom of test hole at approx. 50.5 feet.

PROJECT: Creekside Bible Church Expansion

JOB NO: 24-3566

CLIENT: Creekside Bible Church

SITE LOCATION: Castle Rock, CO

| Elevation (ft) | Depth (ft) | Graphic Log | Material Descriptions and Drilling Notes | Sample Type | Blow Count | Natural Moisture Content (%) | Natural Dry Density (pcf) | Percent Passing No. 200 Sieve | Atterberg Limits | | Swell/Consolidation (%) at Surcharge Pressure (psf) | Unconfined Compressive Strength (ksf) | USCS Equivalent Classification |
|----------------|------------|---|--|-------------|------------|------------------------------|---------------------------|-------------------------------|------------------|------------------|---|---------------------------------------|--------------------------------|
| | | | | | | | | | Liquid Limit | Plasticity Index | | | |
| 6338 | 0 | | TOPSOIL: Approximately 6 inches of topsoil. | | | | | | | | | | |
| 6333 | 5 |  | FILLS: Clays with sands, clayey to silty sands and gravels. The granular fractions consisted of fine to coarse sands and scattered gravels. They were slightly to highly plastic, slightly moist to moist, and dark brown to gray-brown in color. Iron staining was noted commonly. Roots noted in sample at 3 feet. | ▲ | 13/12 | 10.4 | 119.8 | 35 | 35 | 13 | -0.2 (375) | | GC |
| 6328 | 10 |  | CLAYS: Clays and sandy clays with local clayey to silty sands. The granular fractions consisted of fine sands with scattered medium to coarse sands and gravels. They were slightly to moderately plastic, medium to very stiff / loose to medium dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. Lignite filaments were noted locally. | ▲ | 8/12 | 14.5 | 111.1 | 46 | 32 | 11 | 0 (1000) | | SC |
| 6323 | 15 |  | | ⊗ | 5-4-6 | | | | | | | | |
| 6318 | 20 |  | | ⊗ | 4-6-4 | | | | | | | | |
| 6313 | 25 |  | Groundwater encountered at 23 feet approximately 6 hours after drilling. | ▲ | 8/12 | | | | | | | | |
| 6308 | 30 |  | Groundwater encountered at 29 feet at the time of drilling. | ▲ | 11/12 | 21.8 | 105.2 | | | | | 3 | |
| 6303 | 35 |  | SANDS: Sands with clays and silts and silty to clayey sands with local clays. The granular fractions consisted of fine to coarse sands and gravels. They were slightly plastic, medium dense to dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. | ▲ | 39/12 | | | | | | | | |
| | |  | | ⊗ | 12-17-27 | | | | | | | | |







Bottom of test hole at approx. 39.5 feet.

PROJECT: Creekside Bible Church Expansion

JOB NO: 24-3566

CLIENT: Creekside Bible Church

SITE LOCATION: Castle Rock, CO

| Elevation (ft) | Depth (ft) | Graphic Log | Material Descriptions and Drilling Notes | Sample Type | Blow Count | Natural Moisture Content (%) | Natural Dry Density (pcf) | Percent Passing No. 200 Sieve | Atterberg Limits | | Swell/Consolidation (%) at Surcharge Pressure (psf) | Unconfined Compressive Strength (ksf) | USCS Equivalent Classification |
|----------------|------------|---|--|-------------|------------|------------------------------|---------------------------|-------------------------------|------------------|------------------|---|---------------------------------------|--------------------------------|
| | | | | | | | | | Liquid Limit | Plasticity Index | | | |
| 6335 | 0 | | TOPSOIL: Approximately 7 inches of topsoil. | | | | | | | | | | |
| 6330 | 5 |  | FILLS: Clays with sands, clayey to silty sands and gravels. The granular fractions consisted of fine to coarse sands and scattered gravels. They were slightly to highly plastic, slightly moist to moist, and dark brown to gray-brown in color. Iron staining was noted commonly. Roots noted in sample at 1 foot. | 8/12 | | 11.5 | 120.6 | 31 | 28 | 8 | -0.3 (500) | | SC |
| 6325 | 10 |  | CLAYS: Clays and sandy clays with local clayey to silty sands. The granular fractions consisted of fine sands with scattered medium to coarse sands and gravels. They were slightly to moderately plastic, medium to very stiff / loose to medium dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. Lignite filaments were noted locally. | 12/12 | | | | | | | | | |
| 6320 | 15 |  | | 11/12 | | | | | | | 0 (1750) | | |
| 6315 | 20 |  | | 19/12 | | | | | | | | | |
| 6310 | 25 |  | | 7-9-8 | | | | | | | | | |
| 6305 | 30 |  | SANDS: Sands with clays and silts and silty to clayey sands with local clays. The granular fractions consisted of fine to coarse sands and gravels. They were slightly plastic, medium dense to dense, slightly moist to wet, and brown to gray-brown to gray in color. Iron staining was noted commonly. | 18-16-15 | | 14.5 | SD | 8 | 25 | 8 | | | SP-SC |

Groundwater encountered at 25 feet at the time of drilling.


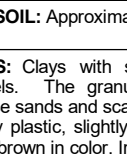
Bottom of test hole at approx. 30.5 feet.

PROJECT: Creekside Bible Church Expansion

JOB NO: 24-3566

CLIENT: Creekside Bible Church

SITE LOCATION: Castle Rock, CO

| Elevation (ft) | Depth (ft) | Graphic Log | Material Descriptions and Drilling Notes | Sample Type | Blow Count | Natural Moisture Content (%) | Natural Dry Density (pcf) | Percent Passing No. 200 Sieve | Atterberg Limits | | Swell/Consolidation (%) at Surcharge Pressure (psf) | Unconfined Compressive Strength (ksf) | USCS Equivalent Classification |
|----------------|------------|---|--|-------------|------------|------------------------------|---------------------------|-------------------------------|------------------|------------------|---|---------------------------------------|--------------------------------|
| | | | | | | | | | Liquid Limit | Plasticity Index | | | |
| 6334 | 0 | | | | | | | | | | | | |
| | |  | TOPSOIL: Approximately 6 inches of topsoil. | ▲ | 18/12 | | | | | | | | |
| 6329 | 5 |  | FILLS: Clays with sands, clayey to silty sands and gravels. The granular fractions consisted of fine to coarse sands and scattered gravels. They were slightly to highly plastic, slightly moist to moist, and dark brown to gray-brown in color. Iron staining was noted commonly. | ⊗ | 5-8-11 | 19.1 | SD | 83 | 48 | 27 | | | (CL)s |

Roots noted in sample at 1 and 4 feet.
Bottom of test hole at approx. 5.5 feet.

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**SECTION 00 5000
CONTRACTING FORMS AND SUPPLEMENTS**

PART 1 GENERAL

1.01 GENERAL

- A. Contractor is responsible for obtaining a valid license to use all copyrighted documents specified but not included in the Project Manual.

1.02 AGREEMENT AND CONDITIONS OF THE CONTRACT

- A. The Agreement is based on AIA A102.
- B. The General Conditions are based on AIA A201.

1.03 FORMS

- A. Use the following forms for the specified purposes unless otherwise indicated elsewhere in Contract Documents.
- B. Post-Award Certificates and Other Forms:
 - 1. Schedule of Values Form: AIA G703.
 - 2. Application for Payment Forms: AIA G702 with AIA G703 (for Contractors).
- C. Clarification and Modification Forms:
 - 1. Architect's Supplemental Instructions Form: AIA G710, or Architect's comparable form.
 - 2. Construction Change Directive Form: AIA G714.
 - 3. Change Order Form: AIA G701.
- D. Closeout Forms:
 - 1. Certificate of Substantial Completion Form: AIA G704.

1.04 REFERENCE STANDARDS

- A. AIA A102 - Standard Form of Agreement Between Owner and Contractor where the basis of payment is the Cost of the Work Plus a Fee with a Guaranteed Maximum Price.
- B. AIA A201 - General Conditions of the Contract for Construction.
- C. AIA G701 - Change Order.
- D. AIA G702 - Application and Certificate for Payment.
- E. AIA G703 - Continuation Sheet.
- F. AIA G704 - Certificate of Substantial Completion.
- G. AIA G710 - Architect's Supplemental Instructions.
- H. AIA G714 - Construction Change Directive.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

**SECTION 01 1000
SUMMARY**

PART 1 GENERAL

1.01 PROJECT

- A. Project Name: Creekside Bible Church Renovation & Addition.
- B. Owner's Name: Creekside Bible Church.
- C. Architect's Name: Lee Architects / Interior Designers.
- D. Additional Project contact information is listed on Drawings.
- E. The Project consists of the selective remodeling of the existing facility, and a building addition including associated site construction, as more completely described in the Contract Documents.

1.02 CONTRACT DESCRIPTION

- A. Contract Type: A single prime contract based on the Cost of the Work plus a fee with a Guaranteed Maximum Price as described in Document 00 5000 - Contracting Forms and Supplements.

1.03 DIVISION 01 SPECIFICATIONS

- A. Division 01 General Requirements expand on the broad provisions of the Conditions of the Contract, and govern the execution of the work of all Sections of the specifications. Division 01 General Requirements specify administrative and procedural requirements relating to execution of the Work, and temporary facilities for use during the construction period.

1.04 PROJECT WARRANTY

- A. Refer to General Conditions for warranty provisions applicable to this Contract.
 - 1. Project warranty period is governed by Colorado state statutes and other provisions of the Contract.
- B. Extended and Other Special Warranties:
 - 1. As identified in other Sections of the specifications, provide written manufacturer's warranties for specific materials, products, and equipment furnished and installed under this Contract.
 - 2. Warranty Periods: Valid for the stated extended period, which may exceed statutory Project warranty period.
 - 3. Warranty Procedures:
 - a. Notify Architect of design conditions which cannot be fully warranted. Submit notice in writing prior to purchase of the affected product or system.
 - b. Failure to provide such notice will not be grounds for waiver of warranty requirements contained in the specifications.
 - c. Upon receipt of such notice, Architect will consider modifications necessary to assure that final construction is warrantable to the full extent of Contract requirements.
- C. Extended Correction Periods:
 - 1. As identified in other Sections of the specifications, provide correction period exceeding one year for specific materials, products, equipment, and work results furnished and installed under this Contract.
 - 2. Correction Periods: Valid for the stated extended time period, which may exceed correction period stipulated in the General Conditions or the Agreement.

1.05 DESCRIPTION OF ALTERATIONS WORK

- A. Scope of demolition and removal work is indicated on Drawings and specified in Section 02 4100.
- B. Scope of alterations work is indicated on Drawings.

1.06 WORK BY OWNER

- A. Items noted NIC (Not in Contract) will be supplied and installed by Owner after Substantial Completion. Some items include:
 - 1. Movable cabinets.
 - 2. Furnishings.
 - 3. Small equipment.
 - 4. Rugs.
 - 5. Artwork.
 - 6. Other items noted on Drawings.

1.07 OWNER OCCUPANCY

- A. Owner intends to continue to occupy adjacent portions of the existing building during the entire construction period.
 - 1. Construction Operations: Minimize interference with normal functioning of building and occupants.
 - 2. Limit noise. Radios are not permitted. If construction activities will produce noise which is detrimental to the operation of the facility, schedule these activities during non-occupied hours.
 - 3. Do not impede emergency building evacuation with construction, equipment, materials, and procedures at building entrances and exits.
 - 4. Protect entrances, exits, walkways, and other areas in the vicinity of the construction subject to use by the public from falling objects, or appropriately barricade according to governing regulations.
 - 5. Except as specifically indicated in the Contract Documents, do not permit interruption of mechanical and electrical services, shut down of building systems, services, and utilities without prior approval of Owner's Project Manager.
- B. Schedule the Work to accommodate Owner occupancy in accordance with the Agreement.

1.08 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.
 - 4. Use of site and premises by the public.
- 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.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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**SECTION 01 2000
PRICE AND PAYMENT PROCEDURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Price and payment procedures, including:
 - 1. Construction cost log.
 - 2. Procedures for preparation and submittal of applications for progress payments.
 - 3. Procedures for preparation and submittal of application for final payment.
- B. Contract modification procedures, including:
 - 1. Documentation of modifications in Contract Sum and Contract Time.
 - 2. Modification procedures.
 - 3. Correlation of Contractor submittals based on Contract modifications.

1.02 RELATED REQUIREMENTS

- A. Section 00 5000 - Contracting Forms and Supplements: Forms to be used.

1.03 PRICE PROCEDURES - GENERAL

- A. Contract Cost Log: Establish and maintain a construction cost log, including the status of all Contract Modifications (Change Orders); including those which have been accepted, declined, pending, etc.), the status of requests for information, supplemental instructions, other modification documents, and the status of allowances, including Owner's contingency allowance.

1.04 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 electronically within 15 days after date of Owner-Contractor Agreement.
- D. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification Section. Identify site mobilization.
- E. Revise schedule to list approved Change Orders, with each Application For Payment.

1.05 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.
 - 1. Forms filled out by hand will not be accepted.
- C. 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. Executed Change Orders.
 7. Total Completed and Stored to Date of Application.
 8. Percentage of Completion.
 9. Balance to Finish.
 10. Retainage.
- D. Execute certification by signature of authorized officer.
- E. 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.
- F. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of work.
- G. Submit electronic copies of each Application for Payment.
- H. Include the following with the application:
1. Transmittal letter as specified for submittals in Section 01 3000.
 2. Construction progress schedule, revised and current as specified in Section 01 3000.
 3. Conditional release of liens from each Subcontractor and vendor for the current month's payment application, and unconditional release of liens from each Subcontractor and vendor for the previous month's payment application.
 4. Project record documents as specified in Section 01 7800, for review by Owner which will be returned to the Contractor.
 5. Affidavits attesting to off-site stored products.
- I. 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.

1.06 MODIFICATION PROCEDURES

- A. Contractor is responsible for informing and coordinating others, in Contractor's employ and affected subcontractors, of modifications to the Contract Documents.
- B. Supplemental Instructions: For minor modifications not involving an adjustment to the Contract Sum or Contract Time; Architect will issue instructions directly to Contractor.
1. Architect's issuance of supplemental instructions may constitute a modification of the Contract Documents involving an adjustment to the Contract Sum or Contract Time. If Architect's supplemental instructions require such a modification of the Contract Documents, notify Owner immediately and prepare a request for change order or other modification according to applicable modification procedures specified in this Section. Owner's approval is required before any action is taken.
- C. Construction Change Directive: For other required modifications, Architect will issue a document signed by Architect and Owner instructing Contractor to proceed with the modification, 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.

- D. Proposal Request: For modifications for which advance pricing is desired, Architect will issue a document which includes a detailed description of a proposed modification with supplementary or revised drawings and specifications, a modification in Contract Time for executing the modification 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 10 days.
- E. Contractor may propose a change by submitting a request for change order or modification to Architect, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation and a statement describing the effect on Work by separate or other contractors.
 - 1. Document any requested substitutions in accordance with Section 01 2500 - Substitution Procedures.
- F. 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 Owner and 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.
- G. Substantiation of Costs: Provide full information required for evaluation.
 - 1. Provide the following data:
 - a. Quantities of products, labor, and equipment.
 - b. Taxes, insurance, and bonds.
 - c. Overhead and profit.
 - d. Justification for any change in Contract Time in accordance with the Agreement.
 - 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.
- H. Execution of Change Orders: Contractor will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.
- I. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.
- J. 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.
- K. Promptly enter changes in Project Record Documents.

1.07 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 01 7000.
 - 2. Receipt of final Certificate of Occupancy from jurisdictional authority.
 - 3. Acceptance of Work by Owner and Architect.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

**SECTION 01 2500
SUBSTITUTION PROCEDURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

- A. Section 01 6000 - Product Requirements: Fundamental product requirements, product options, delivery, storage, and handling, and substitution limitations.

1.03 DEFINITIONS

- A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
 - 1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control.
 - a. Unavailability.
 - b. Regulatory changes.
 - c. Other limitations specified in Section 01 6000.
 - 2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.
 - a. Substitution requests offering advantages solely to the Contractor will not be considered.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Basis of Design Substitutions: If a basis of design product is proposed to be substituted, submit request for substitution of any other manufacturer listed under "Other Acceptable Manufacturers", if that list is included. Otherwise, submit request for substitution any other manufacturer that is capable of providing the specified product meeting specified requirements.
- B. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
 - 2. Agrees to provide the same warranty for the substitution as for the specified product.
 - 3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
 - 4. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
 - 5. Waives claims for additional costs or time extension that may subsequently become apparent.

- C. A Substitution Request for specified installer constitutes a representation that the submitter:
 - 1. Has acted in good faith to obtain services of specified installer, but was unable to come to commercial, or other terms.

- D. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
 - 1. Note explicitly any non-compliant characteristics.
 - 2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.
 - 3. Architect will notify Contractor in writing of decision to accept or reject request.

- E. Substitution Request Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
 - 1. No specific form is required. Contractor's Substitution Request documentation must include the following:
 - a. Project Information:
 - 1) Official project name and number, and any additional required identifiers established in Contract Documents.
 - 2) Owner's, Architect's, and Contractor's names.
 - b. Substitution Request Information:
 - 1) Discrete and consecutive Substitution Request number, and descriptive subject/title.
 - 2) Indication of whether the substitution is for cause or convenience.
 - 3) Issue date.
 - 4) Reference to particular Contract Document(s) specification section number, title, and article/paragraph(s).
 - 5) Description of Substitution.
 - 6) Reason why the specified item cannot be provided.
 - 7) Differences between proposed substitution and specified item.
 - 8) Description of how proposed substitution affects other parts of work.
 - c. Attached Comparative Data: Provide point-by-point, side-by-side comparison addressing essential attributes specified, as appropriate and relevant for the item:
 - 1) Physical characteristics.
 - 2) In-service performance.
 - 3) Expected durability.
 - 4) Visual effect.
 - 5) Sustainable design features.
 - 6) Warranties.
 - 7) Other salient features and requirements.
 - 8) Include, as appropriate or requested, the following types of documentation:
 - (a) Product Data:
 - (b) Samples.
 - (c) Certificates, test, reports or similar qualification data.
 - (d) Drawings, when required to show impact on adjacent construction elements.
 - d. Impact of Substitution:
 - 1) Savings to Owner for accepting substitution.
 - 2) Change to Contract Time due to accepting substitution.

- F. Limit each request to a single proposed substitution item.
 - 1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

- A. Architect may consider requests for substitution only within 60 days after date established in Notice to Proceed, unless otherwise determined by Architect to be acceptable under extenuating circumstances.
 - 1. Substitutions will also be considered when a Product, through no fault of Contractor, becomes unavailable or unsuitable due to regulatory change.
- B. Submit request for Substitution for Cause within 14 days of discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
- C. Submit request for Substitution for Convenience within 14 days of discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
 - 1. In addition to meeting general documentation requirements, document how the requested substitution benefits the Owner through cost savings, time savings, greater energy conservation, or in other specific ways.
 - 2. Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.
 - 3. Bear the costs engendered by proposed substitution of:
 - a. Other construction by Owner.
 - b. Other unanticipated project considerations.
- D. Substitutions will not be considered under one or more of the following circumstances:
 - 1. When they are indicated or implied on shop drawing or product data submittals, without having received prior approval.
 - 2. Without a separate written request.
 - 3. When acceptance will require revisions to Contract Documents.

3.03 RESOLUTION

- A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.
- B. Architect will notify Contractor in writing of decision to accept or reject request.
 - 1. Architect's decision following review of proposed substitution will be noted on the submitted form.

3.04 ACCEPTANCE

- A. Accepted substitutions modify the Contract, and thereby change the Work of the Project. They will be documented and incorporated into Work of the project by Change Order, or similar instrument provided for in the Conditions of the Contract.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. Include completed and approved Substitution Request Forms as part of the Project record.

END OF SECTION

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SECTION 01 3000
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General administrative requirements.
- B. Administrative meetings, including:
 - 1. Preconstruction meeting.
 - 2. Progress meetings.
- C. Administrative procedures, including:
 - 1. Construction progress schedule.
 - 2. Submittals for review, information, and project closeout.
 - 3. Number of copies of submittals.
 - 4. Requests for Information (RFI) procedures.
 - 5. Submittal procedures.

1.02 GENERAL ADMINISTRATIVE REQUIREMENTS

- A. Comply with requirements of Section 01 7000 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.
- B. Make the following types of submittals to Architect:
 - 1. Requests for Information (RFI).
 - 2. Requests for substitution.
 - 3. Shop drawings, product data, and samples.
 - 4. Test and inspection reports.
 - 5. Design data.
 - 6. Manufacturer's instructions and field reports.
 - 7. Applications for payment and change order requests.
 - 8. Progress schedules.
 - 9. Coordination drawings.
 - 10. Correction Punch List and Final Correction Punch List for Substantial Completion.
 - 11. Closeout submittals.
 - 12. Other specified submittals.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Meeting Minutes: Submit meeting minutes for each type of meeting as specified in this Section.
- C. Construction Progress Schedule: Submit construction progress schedule according to the requirements specified in this Section.
- D. Submittal Schedule: Submit submittal schedule according to the requirements specified in this Section.
- E. Progress Photographs and Documentation: Submit photographic project documentation as specified in this Section.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

- A. Architect will schedule a meeting after Notice to Proceed.
- B. Attendance Required:
 - 1. Owner.
 - 2. Architect.
 - 3. Contractor.
 - 4. Other invited participants.
- C. Minimum Agenda:
 - 1. Execution of Owner-Contractor Agreement.
 - 2. Submission of executed bonds and insurance certificates.
 - 3. Distribution of Contract Documents.
 - 4. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
 - 5. Submission of initial Submittal schedule.
 - 6. Submission of list of known or anticipated substitution requests.
 - 7. Designation of personnel representing the parties to Contract, including Contractor, Owner, and Architect.
 - 8. Procedures and processing of field decisions, RFI's, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 - 9. Scheduling.
 - 10. Scheduling activities of the Owner's geotechnical engineer.
- D. Record minutes and distribute electronically within two days after meeting to participants, with copies to Architect, Owner, participants, and those affected by decisions made.

3.02 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the work at weekly intervals, unless otherwise agreed upon and approved by Owner.
- 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. Minimum Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems that impede, or will impede, planned progress.

5. Review of submittals schedule and status of submittals.
6. Review of RFIs log and status of responses.
7. Review of known or anticipated substitution requests.
8. Modification (Change Order) status.
9. Review of off-site fabrication and delivery schedules.
10. Maintenance of progress schedule.
11. Corrective measures to regain projected schedules.
12. Planned progress during succeeding work period.
13. Coordination of projected progress.
14. Maintenance of quality and work standards.
15. Effect of proposed changes on progress schedule and coordination.
16. Other business relating to work.

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

3.03 PROJECT CLOSEOUT MEETING

- A. Specified in Section 01 7000 - Execution and Closeout Requirements.

3.04 CONSTRUCTION PROGRESS SCHEDULE

- 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 Subcontractors 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.

3.05 PROGRESS PHOTOGRAPHS AND DOCUMENTATION

- A. Document existing conditions in the work area prior to start of demolition. Take initial photographs in quantity and at locations required to fully document existing conditions which may become concealed as the result of new Work.
- B. Submit initial photographs to Owner and Architect, and discuss existing conditions that are a concern of Contractor in relation to proposed new Work.
- C. Take additional photographs as Work progresses, at same locations and from same viewing angles as initial photographs.
- D. Submit additional photographs with each application for payment, taken not more than 3 days prior to submission of application for payment.
- E. Maintain one set of all photographs at project site for reference; same copies as submitted, identified as such.
- F. Photography Type: Digital; electronic files; each photograph integrally date-stamped.

- G. 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.

3.06 REQUESTS FOR INFORMATION (RFI)

- A. Definition: A request seeking one of the following:
1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
 2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.
- C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
1. Prepare a separate RFI for each specific item.
 - a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
 - b. Do not forward requests which solely require internal coordination between subcontractors.
 2. Combine RFI and its attachments into a single electronic file. PDF format is required.
- D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
 2. Unacceptable Uses for RFIs: Do not use RFIs to request the following:
 - a. Approval of submittals (use procedures specified elsewhere in this Section).
 - b. Approval of substitutions (see Section - 01 6000 - Product Requirements).
 - c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
 - d. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
 3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
 4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.
 - a. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect, and any of its consultants, due to processing of such RFIs.

- E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
1. Official Project name and number, and any additional required identifiers established in Contract Documents.
 2. Owner's, Architect's, and Contractor's names.
 3. Discrete and consecutive RFI number, and descriptive subject/title.
 4. Issue date, and requested reply date; "ASAP", "As Soon as Possible", or "Immediately" not acceptable as reply date.
 5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
 6. Annotations: Field dimensions and/or description of conditions which have engendered the request.
 7. Contractor's Suggested Resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.
- F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- G. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
1. Indicate current status of every RFI. Update log promptly and on a regular basis.
 2. Note dates of when each request is made, and when a response is received.
 3. Highlight items requiring priority or expedited response.
 4. Highlight items for which a timely response has not been received to date.
- H. Review Time: Architect will respond and return RFIs to Contractor within 10 business days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.
- I. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
 2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
 3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
 4. Notify Architect within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.07 SUBMITTAL SCHEDULE

- A. Submit to Architect for review a schedule for submittals in tabular format.
 - 1. Provide initial schedule at first progress meeting, and provide updated and current schedule at each progress meeting.
 - a. Secure Architect's approval of submittal schedule before making any other product-related submittals.
 - 2. Coordinate with Contractor's construction schedule, schedule of values, and facility services coordination requirements.
 - 3. Format schedule to allow time for all facility services coordination conflicts to be identified and resolved as specified in Section 01 3114 before transmitting associated submittals.
 - 4. Format schedule to allow tracking of status of submittals throughout duration of construction.
 - 5. Include in schedule anticipated dates for each submittal to Architect, required dates of return of reviewed submittal to Contractor, and any required lead times associated with applicable submittals.
 - a. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - b. Arrange information to include specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
 - 6. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.
 - a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.
 - b. If Contractor fails to submit a submittal schedule, Contractor will not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.
- B. Coordinate submittals into logical groupings to facilitate interrelation of the several items:
 - 1. Submit complete package of specified submittals for each product or system, generally associated with an individual specification Section. Partial submittals will not be reviewed, and no delay claim will be considered as the result of a partial submittal being returned for proper resubmittal.
 - 2. Submit all structural concrete shop drawings, product data, schedules, and other specified submittal information in a single package as specified in Division 03.
 - 3. Submit all door, frame, and hardware product data, schedules, and other specified submittal information in a single package as specified in Division 08.

3.08 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.
 - 5. Coordination drawings specified in Section 01 3114 - Facility Services Coordination.
- B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
- C. Samples will be reviewed for aesthetic, color, or finish selection as applicable.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 7800 - Closeout Submittals.

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

3.10 SUBMITTALS FOR PROJECT CLOSEOUT

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

3.11 NUMBER OF COPIES OF SUBMITTALS

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

3.12 SUBMITTAL PROCEDURES - GENERAL

- A. General Requirements:
 - 1. Submit separate packages of submittals for review and submittals for information, when included in the same specification Section.
 - 2. Transmit using approved form.
 - a. Use Contractor's form, subject to prior approval by Architect.

3. Sequentially identify each item. For revised submittals use original number and a sequential combination numerical and alphabetical suffix.
4. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
5. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
 - a. Submittals not bearing Contractor's review stamp, indicating both review and approval, will not be reviewed and be returned for required review.
 - b. Submittals from sources other than Contractor will not be acknowledged, reviewed, or returned.
6. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
7. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. For each submittal for review, allow 15 business days excluding delivery time to and from the Contractor.
 - b. Review time will be extended day-for-day if legal holiday(s) are within the projected review time period.
 - c. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.
 - d. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Architect's approval, allow an additional 30 days.
8. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
9. Provide space for Contractor and Architect review stamps.
10. When revised for resubmission, identify all changes made since previous submission. Include brief description or narrative of what and how review comments were addressed.
11. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
12. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
13. Submittals not reviewed by Contractor will be rejected, and will not be reviewed by Architect. Claims for delay as the result of submittals not reviewed by Contractor will not be allowed.
14. Submittals not requested will be recognized, and will be returned "Not Reviewed".

B. Product Data Procedures:

1. Submit only information required by individual specification sections.
2. Collect required information into a single submittal.
3. Submit concurrently with related shop drawing submittal.
4. Do not submit (Material) Safety Data Sheets for materials or products.
5. Manufacturer's Catalog Submittals: If manufacturer's published catalog information is used as part of a submittal, include only those pages from catalog that are specifically applicable to the proposed products for this Project.
 - a. Clearly identify in the submittal those specific products and components for which review and action is requested.
 - b. Submittals received that do not clearly identify specific applicable products, or that include more pages than those specifically applicable to the subject submittal, will be returned as "not reviewed" and the time for submittal review will not commence until a properly scoped submittal is received by Architect.

C. Shop Drawing Procedures:

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

D. Samples Procedures:

1. Transmit related items together as single package to Architect's office, unless otherwise specified.
2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.
3. Include with transmittal high-resolution image files of samples to facilitate electronic review and approval. Provide separate submittal page for each item image.

3.13 SUBMITTAL REVIEW

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

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

C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.

1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.

D. Architect's Actions:

1. Architect will review each submittal, mark it with appropriate "action," and return it to Contractor within specified time allowance; except when it must be held for coordination, and Contractor is so advised.
2. Where submittals include materials, products, systems, or manufacturers not specified, approved by Addendum prior to execution of the Contract, or approved in writing in conjunction with the proposed products list submittal specified in Section 01 6000 - Product Requirements, Architect reserves the right to exceed the specified time allowance to allow sufficient time to determine the acceptability of such items, and no claim for delay by Contractor will be allowed.
3. Where submittals include a material, product, system, or manufacturer substitution which has not been previously accepted or approved in writing, Architect reserves the right to reject such submittal and require a compliant submittal, or may direct that other action be taken by Contractor to achieve compliance with Contract Documents, and no claim for delay by Contractor will be allowed.
4. Architect's review is for general conformance only and does not relieve Contractor from full compliance with the Contract Documents.

END OF SECTION

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**SECTION 01 3114
FACILITY SERVICES COORDINATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Coordination of facility services construction.
- B. Services of a coordinator for facility services construction.
- C. Coordination documents.

1.02 MECHANICAL AND ELECTRICAL COORDINATOR

- A. Provide staff dedicated to this Project who are technically qualified and administratively experienced in field coordination of the type of work required to be coordinated, for the duration of the Work.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of above-ceiling coordinated items; require attendance by all affected installers.
 - 1. Convene under general provisions of Section 01 7000.
 - 2. Discuss installation of coordinated items above ceilings and other areas where coordination is required.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for general submittal procedures.
 - 1. Submit coordination drawings to Architect as an action submittal as defined in Section 01 3000.
 - 2. Comply with additional submittal requirements specified in this Section; in the event of conflict, the submittal requirements specified in this Section take precedence.
- B. Coordination Drawings - General:
 - 1. Prepare coordination drawings according to specified requirements, and additionally where installation is not completely indicated on shop drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
 - 2. Submit coordination drawings indicating proper and complete resolution of all detected conflicts according to requirements specified in this Section, and in other applicable Sections of the specifications including but not limited to Sections in Divisions 21, 22, 23, 26, 27, and 28.
 - 3. Submit coordination drawings and schedules prior to submitting associated shop drawings, product data, and samples.
 - 4. Submit coordination drawings in a timely manner to facilitate proper coordination with the construction schedule, and to avoid adverse impacts on progress of construction.
 - 5. Fabrication of ductwork, fire protection piping, and other prefabricated systems is at risk until coordination drawings have been completed, reviewed, and approved by Contractor and Architect.
 - 6. Ceilings may not be lowered to resolve apparent conflicts without written approval of Owner and Architect.

- C. Coordination Drawings - Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the required work results.
 2. Plenum Space: Indicate subframing for support of ceiling, and wall systems, mechanical and electrical equipment, and related work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components, and provide a proposed resolution of the conflict for review and approval.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. HVAC and Plumbing Work: Show at least the following:
 - a. Runs of vertical and horizontal piping 1-1/4 inch in diameter and larger.
 - b. Non-pressure gravity piping.
 - c. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - d. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - e. Fire-rated enclosures around ductwork.
 6. Electrical Work: Show at least the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inch in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor-control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 7. Fire-Protection System: Show at least the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
- D. Coordination Drawings - Review: Architect will review coordination drawings to confirm that in general the applicable work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not prepared in sufficient scope or detail, or are otherwise deficient, Architect will inform Contractor, who will make required modifications and resubmit.
- E. Coordination Drawings - Digital Data Files: Prepare coordination drawings as digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format or PDF format as previously approved or directed by Architect.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 COORDINATION - GENERAL

- A. See Drawings, Division 23 specifications, and Division 26 specifications for mechanical/electrical coordination schedules which define responsibilities for providing, setting, and final connecting of applicable devices and equipment items.
- B. Coordinate the work listed below; additional coordination requirements may be specified in these Divisions of the specifications:
 - 1. Fire Suppression: Division 21.
 - 2. Plumbing: Division 22.
 - 3. Heating, Ventilating, and Air Conditioning: Division 23.
 - 4. Electrical: Division 26.
 - 5. Communications: Division 27.
 - 6. Electronic Safety and Security: Division 28.
 - 7. All facility construction work affected by work listed above.
 - 8. All Owner-furnished work affected by work listed above.
- C. Coordinate progress schedules, including but not limited to dates for submittals and for delivery of products.
- D. Conduct meetings among subcontractors and others concerned, to establish and maintain coordination and schedules, and to resolve coordination matters in dispute.
 - 1. Comply with preinstallation meeting requirements specified in this Section.
- E. Participate in progress meetings as specified in Section 01 3000. Report on progress of work to be adjusted under coordination requirements, and any required changes in schedules. Transmit minutes of meetings and reports to concerned parties.

3.02 COORDINATION OF INSTALLATIONS - GENERAL

- A. Comply with manufacturer's installation instructions and recommendations to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in the Contract Documents.
- B. Coordinate installation of materials and equipment above and below ceilings with suspension systems, light fixtures, and other building components. Where mounting heights are not detailed or dimensioned, install services and overhead equipment to provide the maximum headroom possible.
- C. Coordinate ceiling and joist cavity space carefully with all affected trades. In the event of conflict, install mechanical and electrical systems within the cavity space allocation in the following order of priority:
 - 1. Plumbing gravity waste piping and roof drain piping.
 - 2. Fire sprinkler piping main lines.
 - 3. Fire sprinkler branch piping and sprinkler head run outs.
 - 4. Low voltage systems and fire alarm systems.
 - 5. Other facility services components as indicated on Drawings.

- D. Coordinate installation of equipment and piping support, sleeves, and other structural components that penetrate walls, floors, ceilings, or roofs.

3.03 COORDINATION DOCUMENTS - GENERAL

- A. Prepare coordination drawings as specified in this Section to organize installation of products for efficient use of available space, for proper sequence of installation, and to identify potential conflicts.
- B. Prepare a master schedule identifying responsibilities for activities that directly relate to this work, including submittals and temporary utilities; organize by specification Section.
- C. Identify electrical power characteristics and control wiring required for each item of equipment.
- D. Maintain coordination documents for the duration of the Work, record changes due to site instructions, modifications, or adjustments as directed by Architect or required for proper coordination of installations as specified in this Section.
- E. After Architect review of original and revised documents, reproduce and distribute copies to concerned parties.

3.04 COORDINATION OF SUBMITTALS

- A. Review shop drawings, product data, and samples for compliance with Contract Documents and for coordination with related work. Transmit copies of reviewed documents to Architect.
- B. Check field dimensions and clearances and relationship to available space and anchors.
- C. Check compatibility with equipment and work of other Sections, electrical characteristics, and operational control requirements.
- D. Check motor voltages and control characteristics.
- E. Coordinate controls, interlocks, wiring of switches, and relays.
- F. Coordinate wiring and control diagrams.
- G. When changes in the work are made, review their effect on other work.
- H. Verify information and coordinate maintenance of record documents.

3.05 COORDINATION OF SUBSTITUTIONS AND MODIFICATIONS

- A. Review proposals and requests for substitution prior to submission to Architect.
- B. Verify compliance with Contract Documents and for compatibility with work of other Sections.

3.06 INSPECTION OF WORK

- A. Inspect work for compliance with Contract Documents.
- B. Maintain a list of observed deficiencies and defects; promptly submit to Architect.

3.07 TESTING DOCUMENTATION

- A. Observe and maintain a record of tests. Record:
 1. Specification Section number and product name.
 2. Name of Contractor, subcontractor and installer if applicable.

3. Name of testing agency and name of inspector.
4. Name of manufacturer's representative present.
5. Date, time, and duration of tests.
6. Type of test, and results.
7. Retesting required.

B. Assemble background documentation and retain in the event that dispute resolution becomes necessary.

3.08 EQUIPMENT START-UP

- A. Verify utilities, connections, and controls are complete and equipment is in operable condition as required by Section 01 7000.
- B. Comply with general requirements for equipment start-up specified in other Sections of the specifications including but not limited to applicable Sections in Divisions 22, 23, and 26.
- C. Observe start-up and adjustments, test run, record time and date of start-up, and results.
- D. Observe equipment demonstrations made to Owner; record times and additional information required for operation and maintenance manuals.

3.09 INSPECTION AND ACCEPTANCE OF EQUIPMENT

- A. Prior to inspection, verify that equipment is tested, operational, clean, and ready for operation.

END OF SECTION

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**SECTION 01 4000
QUALITY REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General quality requirements, including:
 - 1. Quality assurance and quality control submittals.
 - 2. Quality assurance.
 - 3. References and standards.
 - 4. Testing and inspection agencies and services.
- B. Specific quality requirements, including:
 - 1. Contractor's construction-related professional design services.
 - 2. Contractor's design-related professional design services (delegated design work).
 - 3. Control of installation.
 - 4. Mock-ups.
 - 5. Tolerances.
 - 6. Manufacturer's field services.
 - 7. Defect assessment.
- C. Basis of design specifications.

1.02 DEFINITIONS

- A. Contractor's Professional Design Services: Design of some aspect or portion of the project by party other than the design professional of record. Provide these services as part of the Contract for Construction.
 - 1. Design Services Types Required:
 - a. Construction-Related: Services Contractor needs to provide in order to carry out the Contractor's sole responsibilities for construction means, methods, techniques, sequences, and procedures.
 - b. Design-Related: Design services explicitly required to be performed by another design professional due to highly-technical and/or specialized nature of a portion of the project. Services primarily involve engineering analysis, calculations, and design, and are not intended to alter the aesthetic aspects of the design.
- B. Design Data: Design-related, signed and sealed drawings, calculations, specifications, certifications, shop drawings and other submittals provided by Contractor, and prepared directly by, or under direct supervision of, design professional appropriately licensed in Colorado.

1.03 CONTRACTOR'S CONSTRUCTION-RELATED PROFESSIONAL DESIGN SERVICES

- A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.
- B. Provide such engineering design services as may be necessary to plan and safely conduct certain construction operations, pertaining to, but not limited to the following:
 - 1. Temporary sheeting, shoring, or supports.
 - 2. Temporary scaffolding.
 - 3. Temporary bracing.
 - 4. Temporary falsework for support of spanning or arched structures.

5. Temporary stairs or steps required for construction access only.
6. Temporary hoist(s) and rigging.
7. Investigation of soil conditions to support construction equipment.

1.04 CONTRACTOR'S DESIGN-RELATED PROFESSIONAL DESIGN SERVICES (DELEGATED DESIGN WORK)

- A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions of the Contract for Construction.
- B. Performance and Design Requirements: Where professional design services or certifications by a licensed design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with requirements specified in individual specification Sections.
 1. Base design of products and systems on performance and design criteria indicated or specified in individual specification Sections.
 2. Submit a Request for Information to Architect if the criteria indicated or specified are not sufficient to perform required design services.
- C. Scope of Contractor's Professional Design Services is specified in the following Sections, which include but may not be limited to:
 1. Section 06 1753 - Shop-Fabricated Wood Trusses.
 2. Section 07 6200 - Sheet Metal Flashing and Trim.
 3. Section 07 8400 - Firestopping.
 4. Section 08 4313 - Aluminum-Framed Storefronts.
 5. Section 08 8000 - Glazing.
 6. Section 31 6613.13 - Rammed Aggregate Piers.
- D. Design of building systems, or components of systems, to be provided by Contractor; refer to applicable Division 21 and 28 Sections:
 1. Fire sprinkler systems.
 2. Electronic safety and security systems.
- E. Contractor's Responsibilities:
 1. Coordinate design and space requirements with other affected work and Architect.
 2. Review applicable submittals and coordinate selections with Architect.
 3. Receive and unload products and systems at the site; inspect for completeness and for damage.
 4. Handle, store, install, and finish products and systems.
 5. Repair or replace damaged, defective, or missing items.
 6. Arrange for manufacturer's warranties, inspections, and service.
 7. Comply with applicable provisions of Division 01 - General Requirements, specifically including administrative requirements, coordination, quality, regulatory, and product requirements.
 8. Coordinate delegated design work with Sections 07 8400 - Firestopping, 08 3100 - Access Doors and Panels, applicable Division 09 painting Sections, and applicable Division 23 HVAC instrumentation and control Sections. Provide work scope specified in these Sections that is applicable to delegated design work.

1.05 SUBMITTALS

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

- B. Design Data: Submit for Architect's knowledge for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.
 - 1. Include calculations that have been used to demonstrate compliance to performance and regulatory criteria provided, and to determine design solutions.
 - 2. Include required product data and shop drawings.
 - 3. Include a statement or certification attesting that design data complies with criteria indicated, such as building codes, loads, functional, and similar engineering requirements.
 - 4. Include signature and seal of design professional responsible for allocated design services on calculations and drawings.
 - 5. Provide additional copies of design data for Architect's design consultants, including but not limited to structural engineer, mechanical engineer, plumbing engineer, and electrical engineer; transmit to each design consultant's address concurrently, if requested by Architect.
- C. 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.
- D. Subcontractor, Trade Contractor and Installer Qualifications: When specified in individual specification Sections, submit qualifications data substantiating specified qualifications; three copies, one of which will be reviewed and returned to Contractor indicating action taken.
- E. 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.
- F. Manufacturer's Field Reports: When specified in individual specification Sections, submit reports for Architect's benefit as contract administrator or for Owner.
 - 1. Submit report in duplicate within 30 days of observation to Architect for information.
 - 2. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.
- G. Warranty Documentation: When specified in individual specification Sections, submit specified manufacturer warranty indicating all required inclusions and restricted exclusions, and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of Contractor by Contract Documents, provide services of a Professional Engineer experienced in design of this type of work and licensed in Colorado.

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

1.08 TESTING AND INSPECTION AGENCIES AND SERVICES

- A. Special Testing and Inspection: It is recognized that specified special testing and inspection program is intended to assist Contractor, Owner, Architect, and jurisdictional authorities in nominal determination of probable compliance with specified requirements for certain elements of the Work. This program is not intended to limit Contractor's standard quality control program.
 - 1. See Section 01 4533 - Code-Required Special Inspections and Procedures, for special inspection and testing requirements.

1.09 BASIS OF DESIGN SPECIFICATIONS

- A. Individual specification Sections may include a Basis of Design Manufacturer or Product, which forms the basis of the specifications, Drawing details, and other requirements of the Contract Documents. The specified Basis of Design Manufacturer or Product is not intended to exclude other manufacturers, products, or systems which comply with the requirements of the Contract Documents, subject to the provisions and requirements specified in individual specification Sections.
- B. Comply with the administrative requirements for substitutions specified in Section 01 6000 - Product Requirements for proposed products or systems other than the specified Basis of Design Manufacturer or Product.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 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.
 - 1. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- C. 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.
- D. Have work performed by persons qualified to produce required and specified quality.

- E. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 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 and, if applicable, compliance with moisture management materials, claddings, and fenestrations.
- B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.
- C. Integrated Exterior Mock-ups: Construct integrated exterior mock-up as indicated on Drawings. Coordinate installation of exterior envelope materials and products as required in individual Specification Sections. Provide adequate supporting structure for mock-up materials as necessary.
 - 1. Include typical and unique material and fenestration transition conditions, and typical roof applications.
 - 2. Construct mock-up in phased sequence matching sequencing of building construction, so that building envelope and drainage plane details can be observed on mock-up prior to installation on building, and also prior to installation of finish materials on mock-up.
 - 3. When finish materials are installed on mock-up, provide partial cut-away features which leave concealed drainage plane components including weather barriers, flashings, and sealants remain visible for ongoing reference throughout construction process.
- D. Notify Architect fifteen (15) working days in advance of dates and times when mock-ups will be completed and ready for review and evaluation.
- E. Provide supervisory personnel who will oversee mock-up construction. Provide workers that will be employed during the construction at Project.
- F. Tests will be performed under provisions identified in this Section and identified in the respective product specification Sections.
- G. Assemble and erect specified items with specified backing materials, attachment and anchorage devices, weather barriers, flashings, sealants, applied coatings, surface treatments, and finishes.
- H. 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.
- I. Architect will use accepted mock-ups as a comparison standard for the remaining Work.
- J. Where mock-up has been accepted by Architect and is specified in product specification Sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect.

3.03 TOLERANCES

- 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.

3.04 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 of equipment, and inspection of surfaces to receive waterproofing systems as applicable, and to initiate instructions when necessary.
 - 1. Manufacturer's field representative will be required to submit daily reports as specified in this Section, when daily observations and inspections are specified in individual Sections.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.05 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, with Owner's consent.

END OF SECTION

**SECTION 01 4100
REGULATORY REQUIREMENTS**

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Obtain and pay for required permits, fees, licenses, and inspections as stipulated in the Agreement.
- B. Arrange for required regulatory inspections and approvals.
- C. Verify applicable codes and regulations.
- D. Comply with applicable codes and regulations as stipulated in the Agreement.
 - 1. Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities.
 - 2. Contractor is required to promptly report to Architect any nonconformity discovered by or made known to Contractor as a request for information as specified, or in such form as Architect may otherwise require.
- E. Listing of applicable Codes and regulations in this Section is not to be considered complete and all-inclusive; listing refers to primary applicable Codes and regulations only. See Drawings for additional information.

1.02 SUMMARY OF APPLICABLE CODES AND REFERENCE STANDARDS

- A. Federal Regulations (Including but not limited to); currently adopted editions of the following, unless noted otherwise:
 - 1. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
 - 2. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design.
 - 3. 29 CFR 1910 - Occupational Safety and Health Standards.
- B. Town of Castle Rock, Douglas County, and State of Colorado Regulations, and other applicable regulations (including but not limited to); currently adopted editions of the following, unless noted otherwise:
 - 1. Zoning Code: Local jurisdiction.
 - 2. Fire Protection District: Local jurisdiction.
 - 3. ICC A117.1 - Accessible and Usable Buildings and Facilities.
 - 4. ICC (IFC) - International Fire Code.
 - 5. ICC (IBC) - International Building Code.
 - 6. ICC (IPC) - International Plumbing Code.
 - 7. ICC (IMC) - International Mechanical Code.
 - 8. ICC (IFGC) - International Fuel Gas Code.
 - 9. NFPA 70 - National Electrical Code.
 - 10. ICC (IECC) - International Energy Conservation Code.
 - 11. Erosion and Sedimentation Control Regulations: Local jurisdiction, unless otherwise specified.

1.03 RELATED REQUIREMENTS

- A. Section 01 4000 - Quality Requirements: Additional regulatory requirements.

1.04 QUALITY ASSURANCE

- A. Become familiar with applicable requirements of codes and regulations.
- B. Verify that substituted materials and equipment used in the Work meet or exceed requirements of applicable codes and regulations.
- C. Contractor's Designer Qualifications: Refer to Section - 01 4000 - Quality Requirements.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 4533
CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Inspections and testing required by the Building Code, including:
 - 1. Special inspections.
 - 2. Testing services incidental to special inspections.
- B. Inspection and testing report submittals.

1.02 DEFINITIONS

- A. Code or Building Code: ICC (IBC), International Building Code, Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements and specifically, Chapter 17 - Special Inspections and Tests.
- B. Authority Having Jurisdiction (AHJ): Agency or individual officially empowered to enforce the building, fire and life safety code requirements of the permitting jurisdiction in which the Project is located.
- C. Special Inspection and Testing:
 - 1. Special inspections are inspections and testing of materials, installation, fabrication, erection or placement of components and connections mandated by the AHJ that also require special expertise to ensure compliance with the approved Contract Documents and the referenced standards.
 - 2. Special inspections are separate from and independent of tests and inspections conducted by Owner or Contractor for the purposes of quality assurance and contract administration.

1.03 REFERENCE STANDARDS

- A. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- B. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
- C. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing.
- D. ICC (IBC) - International Building Code.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Special Inspection Agency Qualifications: Prior to the start of work, the Special Inspection Agency is required to:
 - 1. Submit agency name, address, and telephone number, names of full time registered Engineer and responsible officer.
 - 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
 - 3. Submit certification that Special Inspection Agency is acceptable to AHJ.

- C. Special Inspection and Test Reports: After each special inspection and test, Special Inspector and Testing Agency are required to promptly submit two electronic copies of each report; one to Architect and one to the AHJ.
1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of Special Inspector.
 - d. Date and time of special inspection.
 - e. Identification of product and specifications Section.
 - f. Location in the Project.
 - g. Type of special inspection.
 - h. Date of special inspection.
 - i. Results of special inspection.
 - j. Compliance with Contract Documents.
 2. Final Special Inspection Report: Document special inspections and correction of discrepancies prior to the start of the associated work.
- D. Certificates: When special inspection requirements are specified in individual specification Sections, Special Inspector is required to submit certification by the manufacturer, fabricator, and installation subcontractor to Architect and AHJ, in quantities specified for Product Data.
1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect and AHJ.

1.05 SPECIAL INSPECTION AND TESTING AGENCY

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

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SPECIAL INSPECTIONS AND TESTING - GENERAL

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

3.02 SCHEDULE OF SPECIAL INSPECTIONS AND TESTING

- A. A schedule of required special inspections and testing for structural work is included in the structural Drawings.
 - 1. Additional special inspection and testing requirements are specified in this Section.

3.03 SPECIAL INSPECTIONS FOR SOILS

- A. Materials and Placement: Verify each item below complies with approved construction documents and approved geotechnical report.
 - 1. Design bearing capacity of material below shallow foundations; periodic.
 - 2. Design depth of excavations and suitability of material at bottom of excavations; periodic.
 - 3. Materials, densities, lift thicknesses; placement and compaction of backfill: continuous.
 - 4. Subgrade, prior to placement of compacted fill verify proper preparation; periodic.
- B. Testing: Classify and test excavated material; periodic.

3.04 SPECIAL INSPECTION AND TESTING AGENCY DUTIES AND RESPONSIBILITIES

- A. Special Inspection and Testing Agency is required to:
 - 1. Verify samples submitted by Contractor comply with the referenced standards and the approved Contract Documents.
 - 2. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 - 3. Perform specified sampling and testing of products in accordance with specified reference standards.
 - 4. Ascertain compliance of materials and products with requirements of Contract Documents.
 - 5. Promptly notify Architect and Contractor of observed irregularities or non-compliance of work or products.
 - 6. Perform additional tests and inspections required by Architect.
 - 7. Submit reports of all tests or inspections specified.
- B. Limits on Special Inspection and Testing Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the work.

3.05 CONTRACTOR DUTIES AND RESPONSIBILITIES

- A. Contractor Responsibilities - General:
 - 1. Deliver to agency at designated location, adequate samples of materials for special inspections that require material verification.
 - 2. Cooperate with agency and laboratory personnel; provide access to approved documents at project site, to the work, to manufacturers' facilities, and to fabricators' facilities.
 - 3. Provide incidental labor and facilities:
 - a. To provide access to work to be tested or inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested or inspected.
 - c. To facilitate tests or 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 or inspection services.
5. Re-testing: Performed by same agency if required because of non-conformance to specified requirements, on instructions from Architect.
 - a. Paid by Contractor if required because of non-conformance to specified requirements.

END OF SECTION

SECTION 01 5000
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary facilities, including:
 - 1. Dewatering.
 - 2. Temporary utilities.
 - 3. Temporary telecommunications services.
 - 4. Temporary sanitary facilities.
 - 5. Field offices.
- B. Temporary controls on Project site, including:
 - 1. Temporary barriers, enclosures, and fencing.
 - 2. Vehicular access and parking.
 - 3. Waste removal facilities and services.
- C. Project identification sign.

1.02 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

1.03 DEWATERING

- A. Provide temporary means and methods for dewatering all temporary facilities and controls.
- B. Maintain temporary facilities in operable condition throughout duration of construction period.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Site Logistics Plan: Showing:
 - 1. Vegetation removal limits.
 - 2. Areas for temporary construction.
 - 3. Temporary site fencing and gate locations.
 - 4. Traffic control measures.
 - 5. Dumpster and waste management facilities.
 - 6. Temporary toilet facilities.
 - 7. Temporary signage locations and details.
 - 8. Field offices.
 - 9. Storage and lay-down areas.
 - 10. Barriers and other temporary facilities.

1.05 TEMPORARY UTILITIES

- A. Owner will provide the following:
 - 1. Electrical power and metering, consisting of connection to existing facilities.
 - 2. Water supply, consisting of connection to existing facilities.
- B. Existing facilities may not be used.
- C. New permanent facilities may not be used.
- D. Use trigger-operated nozzles for water hoses, to avoid waste of water.

1.06 TELECOMMUNICATIONS SERVICES

- A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.
- B. Telecommunications services shall include:
 - 1. Personal computer or lap-top computer dedicated to project telecommunications, with necessary software and printer.
 - 2. Telephone Lines: Minimum of one phone line, reserved for project use only.
 - 3. Internet Connections: Minimum of one; 2.4G or faster.
 - 4. Email: Account/address reserved for project use only.

1.07 TEMPORARY SANITARY FACILITIES

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

1.08 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for Owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
- C. Provide protection for plants designated to remain. Replace damaged plants.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.09 FENCING

- A. Construction: Commercial grade chain link fence.
- B. Provide minimum 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

1.10 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.

1.11 INTERIOR ENCLOSURES

- A. Provide temporary partitions and ceilings as indicated to separate work areas from Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.
- B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces:
 - 1. STC rating of 35 in accordance with ASTM E90.
 - 2. Maximum flame spread rating of 75 in accordance with ASTM E84.
- C. Paint surfaces exposed to view from Owner-occupied areas.

1.12 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.
- F. Do not allow vehicle parking on existing pavement, unless authorized by Owner in writing.

1.13 WASTE REMOVAL

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

1.14 PROJECT IDENTIFICATION

- A. Provide project identification sign of design, construction, and location approved by Owner.
- B. No other signs are allowed without Owner permission except those required by law.

1.15 FIELD OFFICES

- A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack, and drawing display table.
- B. Provide space for Project meetings, with table and chairs to accommodate 10 persons.
- C. Locate offices a minimum distance of 20 feet from structures and permanent site improvements.

1.16 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 01 5713
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary erosion and sediment controls during construction period, including:
 - 1. Prevention of erosion due to construction activities.
 - 2. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
 - 3. Restoration of areas eroded due to insufficient preventive measures.
 - 4. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 REFERENCE STANDARDS

- A. EPA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit.

1.03 PERFORMANCE REQUIREMENTS

- A. Comply with requirements of EPA (NPDES) for erosion and sedimentation control, as specified by the NPDES, for Phases I and II, and in compliance with requirements of Construction General Permit (CGP).
 - 1. Also comply with all more stringent requirements of Erosion and Sedimentation Control Manual of Colorado.
 - 2. Also comply with all requirements of local jurisdiction for erosion and sedimentation control.
- B. Develop and follow an Erosion and Sedimentation Prevention Plan and submit periodic inspection reports.
- C. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
 - 1. Obtain and pay for permits and provide security required by authority having jurisdiction.
 - 2. Owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.
- D. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- E. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
 - 1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
 - 2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.
- F. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
 - 1. Control movement of sediment and soil from temporary stockpiles of soil.
 - 2. Prevent development of ruts due to equipment and vehicular traffic.
 - 3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

- G. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
 - 1. Prevent windblown soil from leaving the project site.
 - 2. Prevent tracking of mud onto public roads outside site.
 - 3. Prevent mud and sediment from flowing onto sidewalks and pavements.
 - 4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
 - H. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 - I. Open Water: Prevent standing water that could become stagnant.
 - J. Maintenance: Maintain temporary preventive measures until permanent measures have been established.
- 1.04 SUBMITTALS
- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
 - B. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance, repair, and corrective action required and accomplished. Include date-stamped photographs of conditions with each inspection report.
 - C. Maintenance Instructions: Provide instructions covering inspection and maintenance for temporary measures that must remain after Substantial Completion.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: See Drawings for materials and other required control measures.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

- A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

- A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.
- B. See Drawings for scope and extent of required erosion and sediment control measures.

3.04 INSTALLATION

- A. General: Install temporary erosion and sediment controls as indicated on Drawings.

3.05 MAINTENANCE

- A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.
- B. Repair deficiencies immediately.

3.06 CLEAN UP

- A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.
- B. Clean out temporary sediment control structures that are to remain as permanent measures.
- C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

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**SECTION 01 6000
PRODUCT REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General product requirements.
- B. Specific product requirements, including:
 - 1. Re-use of existing products.
 - 2. Transportation, handling, storage and protection.
 - 3. Product option requirements.
 - 4. Substitution limitations.
 - 5. Procedures for Owner-supplied products.
- C. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

- A. Section 01 2500 - Substitution Procedures: Substitutions made after award of Contract and during construction phase.
- B. Section 01 4000 - Quality Requirements: Product quality monitoring.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. 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.
- C. 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.
- D. 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.
- E. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
 - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

- A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by Contract Documents.

- B. Unforeseen historic items encountered remain the property of the Owner; notify Owner promptly upon discovery; protect, remove, handle, and store as directed by Owner.
- C. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.

2.02 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by Contract Documents.
- B. See Section 01 4000 - Quality Requirements, for additional source quality control requirements.
- C. Use of products having any of the following characteristics is not permitted:
 - 1. Made using or containing CFC's or HCFC's.
 - 2. Containing lead, asbestos, or other known hazardous substances.

2.03 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.
- D. Products Specified by Naming a Basis of Design Manufacturer or Product with a Provision for Substitutions: Submit a request for substitution for any other manufacturer listed under Other Acceptable Manufacturers, or for a manufacturer not named.
 - 1. Refer to Section 01 4000 for basis of design specifications requirements.

2.04 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification Sections.
- B. Deliver and place in location as directed; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

- A. See Section 01 2500 - Substitution Procedures for general substitution procedures.
- B. Architect may consider requests for substitutions when one or more of the following conditions exist, as determined by Architect. If one or more of the following conditions are determined not to exist, Architect may not consider request further, and may take no action except to record the request and its non-compliance. Consideration may be given if substitution request:
 - 1. Offers Owner substantial advantage in cost, time, energy conservation, or other consideration, after deducting additional responsibilities Owner must assume as the result.
 - 2. Does not require extensive modification of Contract Documents.
 - 3. Is consistent with intent of Contract Documents, and will produce intended work results.

4. Is fully documented and properly submitted.
5. Resolves specified Product being unable to receive required approval by Authority Having Jurisdiction (AHJ), and substitution has received such approval prior to submission.
6. Resolves incompatibility of specified Product with other related Products, and substitution is compatible with related Products.
7. Resolves non-coordination of specified Product with other related Products, and substitution is coordinated with related Products.
8. Provides specified warranty when specified Product cannot be provided with specified warranty.
9. Is proposed for a Product that, through no fault of Contractor, becomes unavailable or unsuitable due to regulatory change.
10. Will be considered if a Product cannot be provided within the Contract Time; Architect will not consider substitution if Product cannot be provided as the result of Contractor's failure to schedule and coordinate the Work as required by Contract Documents.
11. Has been coordinated with and among all affected Subcontractors and other portions of the Work, and is acceptable to all affected Subcontractors.

3.02 OWNER-SUPPLIED PRODUCTS

A. Owner's Responsibilities:

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

B. Contractor's Responsibilities:

1. Designate submittals and delivery date for each product in progress schedule.
2. Review Owner reviewed shop drawings, product data, and samples.
 - a. After review, submit to Architect with notification of any observed discrepancies or problems anticipated due to non-conformance with Contract Documents.
3. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
4. Handle, store, install and finish products.
5. Provide installation inspections required by jurisdictional authorities.
6. Repair or replace items damaged after receipt.

3.03 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.

3.04 STORAGE AND PROTECTION

- A. Provide protection of stored materials and products against theft, casualty, or deterioration.
- B. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
 - 1. Structural Loading Limitations: Handle and store products and materials so as not to exceed static and dynamic load-bearing capacities of project floor and roof areas.
- C. Store and protect products in accordance with manufacturers' instructions.
- D. Store with seals and labels intact and legible.
- E. Arrange storage of materials and products to allow for visual inspection for the purpose of determination of quantities, amounts, and unit counts.
- F. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.
- G. For exterior storage of fabricated products, place on sloped supports above ground.
- H. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- I. Comply with manufacturer's warranty conditions, if any.
- J. Do not store products directly on the ground.
- K. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- L. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- M. Prevent contact with material that may cause corrosion, discoloration, or staining.
- N. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- O. 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 01 7000
EXECUTION AND CLOSEOUT REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Execution procedures, including:
 - 1. Examination, preparation, and general installation procedures.
 - 2. Requirements for alterations work, including selective demolition, except removal, disposal, and/or remediation of hazardous materials and toxic substances.
 - 3. Pre-installation meetings.
 - 4. Cutting and patching.
 - 5. Surveying for laying out the work.
 - 6. Cleaning and protection.
- B. Closeout procedures, including:
 - 1. Starting of systems and equipment.
 - 2. Demonstration and instruction of Owner personnel.
 - 3. Project closeout meeting.
 - 4. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.
- C. General requirements for maintenance service.

1.02 DEFINITIONS

- A. Verify, Field Verify, or Drawing Abbreviation: Use on Drawings or in specifications is intended to alert Contractor that indicated measurement or description of work may not be fully determined without comparing verified dimension in larger context or other dependent measurements due to specific product, actual versus nominal dimensions, or measurements of existing conditions.
 - 1. Notify Architect of discrepancies between dimensions shown and field layout or measurements.

1.03 REFERENCE STANDARDS

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. 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. Alternatives to cutting and patching.
- f. Effect on work of Owner or separate Contractor, if applicable.
- g. Written permission of affected separate Contractor, if applicable.
- h. Date and time work will be executed.

C. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.05 QUALIFICATIONS

- A. For surveying work, employ a land surveyor licensed in Colorado.
- B. For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in Colorado.

1.06 PROJECT CONDITIONS

- A. Use of explosives is not permitted without written permission from Owner.
- B. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- C. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
- D. Perform dewatering activities, as required, for the duration of the project.
- E. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
 - 1. Provide mechanical ventilation of enclosed wood framing exposed to moisture.
 - 2. Provide mold mitigation as required on wood framing exposed to moisture.
- F. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
 - 1. Provide dust-proof enclosures to prevent entry of dust generated outdoors.
- G. Erosion and Sediment Control: Plan and execute work by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
 - 1. Minimize amount of bare soil exposed at one time.
 - 2. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
 - 3. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
 - 4. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.
- H. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
- I. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.
- J. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.07 ADMINISTRATIVE COORDINATION - GENERAL

- A. See Section 01 3114 - Facility Services Coordination, for detailed coordination requirements.
- B. 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.
- C. Notify affected utility companies and comply with their requirements.
- D. 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.
- E. 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.
- F. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- G. Coordinate completion and clean-up of work of separate Sections.
- H. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product Sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitutions: For any proposed change in materials, submit request for substitution described in Section 01 2500 - Substitution Procedures.

PART 3 EXECUTION

3.01 EXAMINATION

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

- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
 - F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.
- 3.02 PREPARATION
- A. Clean substrate surfaces prior to applying next material or substance.
 - B. Seal cracks or openings of substrate prior to applying next material or substance.
 - C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.
- 3.03 PRE-INSTALLATION MEETINGS
- A. When required in individual specification Sections, convene a pre-installation 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 minimum 7 calendar days in advance of proposed 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.
- 3.04 LAYING OUT THE WORK
- A. Verify locations of survey control points prior to starting work.
 - B. Promptly notify Architect of any discrepancies discovered.
 - C. Locate and protect survey control and reference points.
 - D. Control datum for survey is that indicated on Drawings.
 - E. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
 - F. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
 - G. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.
 - H. Utilize recognized engineering survey practices.
 - I. Establish a minimum of two permanent bench marks on site, referenced to established control points. Record locations, with horizontal and vertical data, on project record documents.

- J. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
 - 1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
 - 2. Grid or axis for structures.
 - 3. Building foundation, column locations, ground floor elevations.
- K. Periodically verify layouts by same means.
- L. Maintain a complete and accurate log of control and survey work as it progresses.

3.05 GENERAL INSTALLATION REQUIREMENTS

- A. In addition to compliance with regulatory requirements, conduct construction operations in compliance with NFPA 241, including applicable recommendations in Appendix A.
- B. 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.
- C. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- D. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- E. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- F. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 ALTERATIONS

- A. Photographic Documentation: Specified in Section 01 3000 - Administrative Requirements.
- B. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of alterations work constitutes acceptance of existing conditions.
- C. Keep areas in which alterations are being conducted separated from other areas that are still occupied.
 - 1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 5000.
 - 2. Provide sound retardant partitions of construction indicated on Drawings in locations indicated on Drawings.
- D. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
 - 1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.
 - 2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.
- E. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.

- F. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
 - 2. Relocate items indicated on Drawings.
 - 3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
 - 4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
- G. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
 - 2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
 - 3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
 - b. Provide temporary connections as required to maintain existing systems in service.
 - 4. Verify that abandoned services serve only abandoned facilities.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.
- H. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
- I. Adapt existing work to fit new work. Make as neat and smooth transition as possible.
 - 1. When existing finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect.
 - 2. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
 - 3. Where a change of plane of 1/4 inch or more occurs in existing work, submit recommendation for providing a smooth transition for Architect review and request instructions.
 - 4. Trim existing wood doors as necessary to clear new floor finish. Refinish trim as required.
- J. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
- K. Refinish existing surfaces as indicated:
 - 1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
 - 2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.

- L. Clean existing systems and equipment.
- M. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- N. Do not begin new construction in alterations areas before demolition is complete.
- O. Comply with all other applicable requirements of this Section.

3.07 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. See Alterations article above for additional requirements.
- C. Perform whatever cutting and patching is necessary to:
 - 1. Complete the work.
 - 2. Fit products together to integrate with other work.
 - 3. Provide openings for penetration of mechanical, electrical, and other services.
 - 4. Match work that has been cut to adjacent work.
 - 5. Repair areas adjacent to cuts to required condition.
 - 6. Repair new work damaged by subsequent work.
 - 7. Remove samples of installed work for testing when requested.
 - 8. Remove and replace defective and non-complying work.
- D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- F. Cut rigid materials, resulting in clean and neat edges, using masonry saw or core drill. Cutting rigid materials using chisels, impact or pneumatic tools is not allowed without prior approval.
- G. Restore work with new products in accordance with requirements of Contract Documents.
- H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 8400, to full thickness of the penetrated element.
- J. Patching:
 - 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
 - 2. Match color, texture, and appearance.
 - 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.08 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from wall cavities, pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site weekly and dispose off-site; do not burn or bury.

3.09 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification Sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. 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.
 - 1. Keep waterproofed and roofed surfaces clean and free of debris that could cause damage to surfaces and membranes, particularly sharp objects including fasteners, wire cut-offs, and similar items.
- H. Prohibit traffic from landscaped areas.
- I. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.
- J. Failure to protect installed and existing work may result in withholding of payments to Contractor as determined by Architect. Damage resulting from failure to protect installed and existing work must be fully repaired or replaced as applicable to the satisfaction of Architect at no additional cost to Owner.

3.10 SYSTEM STARTUP

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- D. Verify that wiring and support components for equipment are complete and tested.
- E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
- F. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- G. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.11 DEMONSTRATION AND INSTRUCTION

- A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of Owner's personnel.
- E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. The amount of time required for instruction on each item of equipment and system is that specified in individual Sections.

3.12 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.
- B. Testing, Adjusting, and Balancing HVAC Systems: See Division 23 and Section 01 4000 - Quality Requirements.

3.13 FINAL CLEANING

- A. Execute final cleaning after Substantial Completion but before making final application for payment.
- 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, and 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, gutters, downspouts, 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.

3.14 PROJECT CLOSEOUT MEETING

- A. Schedule and administer a Project closeout meeting minimum two months before scheduled Date of Substantial Completion, at location mutually agreed upon by Owner, Contractor, and Architect.
- B. Attendance Required: Owner, Contractor, job superintendent, and Architect.
- C. Minimum Agenda:
 - 1. Review specified closeout process, tasks required of respective participants, task scheduling, and deadline dates for each critical path task in the closeout process.
 - 2. Review closeout submittals required and submittal procedures for each.
 - 3. Review maintenance materials requirements and Owner's requirements for delivery and storage.
 - 4. Review final inspection requirements of AHJ and coordination of same.
 - 5. Review status of record documentation, and discuss process for completing and distributing record documentation to Owner and Architect.
- D. Record minutes and distribute electronically within two days after meeting to participants and those affected by decisions made.

3.15 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
 - 1. Provide copies to Architect and Owner.
- B. Notify Architect in writing when work is considered ready for Architect's Substantial Completion inspection.
 - 1. Prerequisite for Substantial Completion: In addition to definition of Substantial Completion in the General Conditions or Agreement, Substantial Completion is not considered achieved until Certificate of Occupancy is issued by primary jurisdictional authority, allowing Owner to fully occupy or utilize building and associated facilities for intended use in all respects.
- C. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.
- D. 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.
- E. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- F. Accompany Owner and Architect on Contractor's preliminary final inspection.
- G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.
- H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.16 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 Owner.

END OF SECTION

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**SECTION 01 7800
CLOSEOUT SUBMITTALS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Closeout submittals, including:
 - 1. Project record documents.
 - 2. Operation and maintenance data.
 - 3. Warranties and bonds.

1.02 RELATED REQUIREMENTS

- A. Section 01 3000 - 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.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- C. Operation and Maintenance Data:
 - 1. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 2. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
 - 3. Submit two sets of revised final documents in final form within 10 days after final inspection.
- D. 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

[See next page]

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

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

3.02 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. For Each Product, Applied Material, and Finish:
 - 1. Product data, with catalog number, size, composition, and color and texture designations.
 - 2. Information for re-ordering custom manufactured products, if any.

- 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. Additional information as specified in individual product specification Sections.
- D. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.
- C. 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.
- D. 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.
- E. Provide servicing and lubrication schedule, and list of lubricants required.
- F. Include manufacturer's printed operation and maintenance instructions.
- G. Include sequence of operation by controls manufacturer.
- H. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- I. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- J. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- K. Include test and balancing reports.
- L. Additional Requirements: As specified in individual product specification Sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- A. Assemble operation and maintenance data into electronic files for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification Sections.
 - 1. Where systems involve more than one specification Section, provide separate electronic bookmarked tab for each system.

- B. 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.
- C. Electronic Cover Page: Identify each file with first page titled OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- D. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.
- E. Tables of Contents: List every item 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.
- F. Electronic Bookmarking: Provide electronically bookmarked divider pages in each file for each separate product and system; identify the contents on the divider page; immediately following the divider page include a description of product and major component parts of equipment.
- G. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- H. 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. Electronic scans warranties and bonds.
 - 4. Design Data: To allow for addition of design data furnished by Architect or others, provide a bookmarked divider page labeled "Design Data" and allow for insertion of additional electronic data, if applicable.

3.06 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.
 - 1. Warranties must clearly state that warranty commences on Date of Substantial Completion, and the actual Date of Substantial Completion according to the Contract must be clearly stated on the warranty form.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Retain warranties and bonds until time specified for submittal.
- E. Include photocopies of each in operation and maintenance manuals, indexed separately on Table of Contents.

- F. 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.

END OF SECTION

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**SECTION 02 4100
DEMOLITION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of existing site elements.
- B. Selective demolition of building elements for alteration purposes.

1.02 RELATED REQUIREMENTS

- A. Section 01 7000 - Execution and Closeout Requirements: Additional execution requirements for alterations.

1.03 DEFINITIONS

- A. Demolition: Dismantle, raze, destroy or wreck any building or structure or any part thereof.
- B. Demolish (Demo): Dismantle a defined component of existing construction, remove it from the Site, and dispose of it either as specified or in lawful manner.
- C. Dispose: Remove from the Project Site in lawful manner.
- D. Remove: Detach or dismantle items from existing construction and dispose of them off site, unless items are indicated to be salvaged or reinstalled; definition includes lawful disposal, unless otherwise specifically indicated to be reinstalled, salvaged, or other described action.
- E. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label and deliver salvaged items to Owner in ready-for-reuse condition.
- F. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall where indicated.
- G. Salvage: See Section 01 7419 for primary definition; also, in context, may mean: Remove in a manner preserving the existing condition and integrity of the component, set aside, store and protect for future reinstallation.
- H. Existing to Remain: Designation for existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.04 REFERENCE STANDARDS

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

1.06 SUBMITTALS

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

- B. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
 - 1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades and fences.
 - 2. Demolition firm qualifications.
 - C. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.
- 1.07 QUALITY ASSURANCE
- A. Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of five years of documented experience.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 DEMOLITION

- A. Remove portions of existing building as indicated on Drawings.
- B. Remove paving and curbs required to accomplish new work.
- C. Remove other items as specifically indicated on Drawings.
- D. Remove items specifically indicated for salvage, relocation, and recycling.
- E. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as specified in Section 31 2300.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with requirements in Section 01 7000.
- B. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 8. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
 - 9. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
 - 10. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
- C. Do not begin removal until receipt of notification to proceed from Owner.
- D. Do not begin removal until existing elements to be salvaged or relocated have been removed.

- E. Do not begin removal until vegetation to be relocated has been removed and vegetation to remain has been protected from damage.
- F. Protect existing structures and other elements to remain in place and not removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.
- G. Minimize production of dust due to demolition operations. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- H. Hazardous Materials:
 - 1. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury.
- I. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.03 EXISTING UTILITIES

- A. Protect existing utilities to remain from damage.
- B. Do not disrupt public utilities without permit from authority having jurisdiction.
- C. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- D. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- E. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- F. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
- G. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone. Identify and mark, in same manner as other utilities to remain, utilities to be reconnected.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Photographic Documentation: Specified in Section 01 3000.
- B. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
 - 1. Verify construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- C. Separate areas in which demolition is being conducted from areas that remain occupied.
 - 1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 5000 in locations indicated on Drawings.

- D. Maintain weatherproof exterior building enclosure, except for interruptions required for replacement or modifications; prevent water and humidity damage.
 - E. Remove existing work as indicated and required to accomplish new work.
 - 1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction indicated.
 - 2. Remove items indicated on Drawings.
 - F. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems to remain in operation, and maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. See Section 01 1000 - Summary for limitations on outages and required notifications.
 - 4. Verify that abandoned services serve only abandoned facilities before removal.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings. Remove back to source of supply where possible, otherwise cap stub and tag with identification.
 - G. Protect existing work to remain.
 - 1. Prevent movement of structure. Provide shoring and bracing as required.
 - 2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch to match new work.
- 3.05 DEBRIS AND WASTE REMOVAL
- A. Remove debris and trash from site.
 - B. Remove from site all materials not to be reused on site; do not burn or bury.
 - C. Leave site in clean condition, ready for subsequent work.
 - D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 03 1000
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formwork for cast-in-place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.02 REFERENCE STANDARDS

- A. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
- B. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- C. NSF 372 - Drinking Water System Components - Lead Content; 2022.
- D. NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
- E. PS 1 - Structural Plywood; 2023.

1.03 INFORMATIONAL SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

1.04 QUALITY ASSURANCE

- A. Designer Qualifications: Design formwork under direct supervision of a Professional Structural Engineer experienced in design of concrete formwork and licensed in the State in which the Project is located.

PART 2 PRODUCTS

2.01 FORMWORK - GENERAL

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.
- C. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.

2.02 WOOD FORM MATERIALS

- A. Softwood Plywood: PS 1, B-B High Density Concrete Form Overlay, Class I.

2.03 FORMWORK ACCESSORIES

- A. Form Ties: Removable type, glass-fiber reinforced plastic or metal, fixed length, free of defects that could leave holes larger than 1 inch in concrete surface.
 - 1. Furnish ties that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2. Furnish ties with integral water barrier plates to walls indicated to receive dampproofing or waterproofing.
- B. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
1. Do not use materials containing diesel oil or petroleum-based compounds.
 2. Formulate form release agent with rust inhibitor for steel form-facing materials.
- C. Dovetail Anchor Slot: Galvanized steel, at least 21 gauge, 0.034 inch thick, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- D. Flashing Reglets: Galvanized steel, at least 22 gauge, 0.0299 inch thick, longest possible lengths, with alignment splines for joints, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- E. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 05 1200.
- F. Waterstops: Bentonite and butyl rubber, complying with NSF 61 and NSF 372.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

- A. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.03 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI SPEC-301 and ACI 117.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- D. Align joints and make watertight. Keep form joints to a minimum.
- E. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
1. Obtain approval before framing openings in structural members that are not indicated on drawings.
- F. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- G. Coordinate this section with other sections of work that require attachment of components to formwork.
- H. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect before proceeding.

3.04 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Position recessed anchor slots for brick veneer masonry anchors to spacing and intervals specified in Section 04 2613.
- E. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- G. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
 - 1. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.07 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI SPEC-117, unless otherwise indicated.

3.08 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.

3.09 FORM REMOVAL

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form removal operations, and curing and protection operations need to be maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

END OF SECTION

SECTION 03 2000
CONCRETE REINFORCING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.

1.02 REFERENCE STANDARDS

- A. ACI MNL-66 - ACI Detailing Manual; 2020.
- B. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- C. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- D. ASTM A706/A706M - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement; 2022a.
- E. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars; 2022.
- F. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.
- G. ASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars; 2021.
- H. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- I. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars; 2018, with Amendment (2020).
- J. CRSI (DA4) - Manual of Standard Practice; 2023.

1.03 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Comply with requirements of ACI MNL-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Elevations at 1/4" = 1'-0" scale shall be included to show beam and wall reinforcing layout.

1.04 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.
- B. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- C. Reports: Submit certified copies of mill test report of reinforcement materials analysis.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI SPEC-301.

- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.4/D1.4M and no more than 12 months before start of scheduled welding work.

1.06 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
 - 1. Unfinished.
 - 2. Epoxy coated in accordance with ASTM A775/A775M.
- B. Reinforcing Steel: ASTM A706/A706M, deformed low-alloy steel bars.
- C. Steel Welded Wire Reinforcement (WWR): Plain type; ASTM A1064/A1064M.
- D. Reinforcement Accessories:
 - 1. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
 - 2. Epoxy repair coating: liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.
 - 3. Tie Wire: Annealed, minimum 16 gauge, 0.0508 inch (1.29 mm).
 - 4. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.

2.02 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.
- B. Welding of reinforcement is permitted only with the specific approval of Engineer. Perform welding in accordance with AWS D1.4/D1.4M.
- C. Fabricate and handle epoxy-coated reinforcing in accordance with ASTM D3963/D3963M.

PART 3 EXECUTION

3.01 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Do not displace or damage vapor barrier.
- C. Accommodate placement of formed openings.
- D. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- G. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.02 FIELD QUALITY CONTROL

- A. An independent testing agency, as specified in Section 01 4000 - Quality Requirements, will inspect installed reinforcement for compliance with contract documents before concrete placement. Reinforcing shall be inspected for conformance with Contract documents with regard to bar size, grade, placement, splice lengths, clearance from soil or formwork, supports, and attachment of accessories and embedded items. Inspection shall be according to ACI 318 and IBC chapter 19. Inspect all welded reinforcing steel according to AWS D1.4, IBC chapter 10, and ACI 318.
- B. Inspect all bolts and embedded items that will be cast into concrete. Verify size, spacing, embedment length, and location according to IBC chapter 19.

END OF SECTION

SECTION 03 3000
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete for composite floor construction.
- B. Floors and slabs on grade.
- C. Concrete foundation walls.
- D. Joint devices associated with concrete work.
- E. Concrete curing.

1.02 RELATED REQUIREMENTS

- A. Section 03 2000 - Concrete Reinforcing.
- B. Section 03 3511 - Concrete Floor Finishes: Densifiers, hardeners, applied coatings, and polishing.
- C. Section 07 9200 - Joint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.
- D. Section 32 1313 - Concrete Paving: Sidewalks, curbs and gutters.

1.03 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- B. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
- C. ACI PRC-302.1 - Guide to Concrete Floor and Slab Construction; 2015.
- D. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).
- E. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.
- F. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.
- G. ACI PRC-308 - Guide to External Curing of Concrete; 2016.
- H. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- I. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- J. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.
- K. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2023.
- L. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2021.
- M. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2023.
- N. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
- O. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- P. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2020.

- Q. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).
- R. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).
- S. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.
- T. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2017.
- U. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.
- V. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2021.
- W. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- X. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures; 2020.
- Y. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2018.
- Z. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2018.
- AA. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers; 2020.
- BB. ASTM E1155M - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers (Metric); 2014.
- CC. 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.
- DD. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).

1.04 COORDINATION

- A. Attachments and penetrations:
- B. All proposed penetrations through concrete slabs and beams shall be submitted to the Engineer for approval a minimum of 6 weeks prior to the concrete placement. Submittals shall include the actual opening diameter and location.
 - 1. Core drilling for sleeves or other penetrations is not allowed unless authorized in writing by Engineer.

1.05 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete Subcontractor.

- e. Special concrete finish Subcontractor.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold and hot weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness measurements, concrete repair procedures, and concrete protection.

1.06 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
- C. Mix Design: Submit proposed concrete mix design.
 1. Indicate proposed mix design complies with requirements of ACI SPEC-301, Section 4 - Concrete Mixtures.
 2. Indicate proposed mix design complies with requirements of ACI CODE-318, Chapter 5 - Concrete Quality, Mixing and Placing.
 3. Indicate amounts of mixing water to be withheld for later addition at project site.
- D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 1. Location of construction joints is subject to approval of the Architect.
- E. Vapor Barriers:
 1. Quality Control/Assurance
 - a. Summary of test results per paragraph 9.3 of ASTM E1745.
 - b. Manufacturer's samples and literature.
 - c. Manufacturer's installation instructions for placement, seaming, penetration prevention and repair, and perimeter seal per ASTM E1643.
 - d. All mandatory ASTM E1745 testing must be performed on a single production roll per ASTM E1745 Section 8.1.
 - e. Contact vapor barrier manufacturer to schedule a pre-construction meeting and to coordinate a review, in-person or digital, of the vapor barrier installation.
 - f. Manufacturer's Life of the Building Warranty.
- F. Samples: Submit samples of underslab vapor barrier and waterstops to be used.
- G. Test Reports: Submit report for each test or series of tests specified.
- H. Sustainable Design Submittal: If any fly ash, ground granulated blast furnace slag, silica fume, rice hull ash, or other waste material is used in mix designs to replace Portland cement, submit the total volume of concrete cast in place, mix design(s) used showing the quantity of portland cement replaced, reports showing successful cylinder testing, and temperature on day of pour if cold weather mix is used.
- I. Sustainable Design Submittal: Submit environmental assessment report for concrete mix. Compare concrete mix submitted with a conventional or reference concrete mixture that meets the specified performance requirements. Include:
 1. Energy consumption.
 2. Emissions.
 3. Potential toxicity.
 4. Potential risk.
 5. Raw material consumption.
 6. Land use.

7. Third-party validation of comparison methodology.

1.07 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding Certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
 1. Cementitious materials.
 2. Admixtures.
 3. Form materials and form-release agents.
 4. Steel reinforcement and accessories.
 5. Fiber reinforcement.
 6. Waterstops.
 7. Curing compounds.
 8. Floor and slab treatments.
 9. Bonding agents.
 10. Adhesives.
 11. Joint-filler strips.
 12. Repair materials.
- D. Material Test Reports: For the following, from a qualified testing agency:
 1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- E. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.
- F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- G. Field quality-control reports.
- H. Minutes of preinstallation conference.

1.08 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI SPEC-301, ACI CODE-318, and ACI 117.
- B. Follow recommendations of ACI PRC-305 when concreting during hot weather.
- C. Follow recommendations of ACI PRC-306 when concreting during cold weather.
- D. Installer qualifications: A qualified installer who employs on Project personnel qualified as ACI certified Flatwork Technician and Finisher and a supervisor who is an ACI certified Concrete Flatwork Technician.
- E. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- F. Testing Agency Qualifications: An independent agency, acceptable to authority having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-

certified Concrete Laboratory Testing Technician, Grade II.

G. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement: ASTM C150/C150M, Portland type or ASTM 595. See Concrete Mix Matrix for cement type.

1. Acquire cement for entire project from same source.

B. Fine and Coarse Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded.

1. Acquire aggregates for entire project from same source.

2. Maximum aggregate size as specified in Concrete Mix Matrix.

3. Fine aggregate shall be free of materials with deleterious reactivity to alkali in cement.

C. Fly Ash: ASTM C618, Class C or F.

D. Silica Fume: ASTM C1240, proportioned in accordance with ACI PRC-211.1.

E. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.02 ADMIXTURES

A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement. Do not use calcium chloride or admixtures containing calcium chloride.

B. Air Entrainment Admixture: ASTM C260/C260M.

C. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.

D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.

E. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.

F. Set-Accelerating Admixture: ASTM C494/C494M Type C.

G. Retarding Admixture: ASTM C494/C494M Type B.

H. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

I. Water Reducing Admixture: ASTM C494/C494M Type A.

2.03 ACCESSORY MATERIALS

A. Underslab Vapor Barrier:

1. Sheet Material: ASTM E1745, Class A, 15mil thickness; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. Single-ply polyethylene is prohibited.

2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.

3. Products:

a. Stego Industries, LLC: www.stegoindustries.com/#sle.

B. Non-Shrink Cementitious Grout: Premixed compound consisting of nonmetallic aggregate, cement, water reducing and plasticizing agents.

1. Grout: Comply with ASTM C1107/C1107M.

2.04 BONDING AND JOINTING PRODUCTS

A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.

B. Epoxy Bonding System:

1. Complying with ASTM C881/C881M and of Type required for specific application.

- C. Reglets: Formed steel sheet, galvanized, with temporary filler to prevent concrete intrusion during placement.
- D. Slab Isolation Joint Filler: 1/2-inch thick, height equal to slab thickness, with removable top section forming 1/2-inch deep sealant pocket after removal.
 - 1. Material: ASTM D1751, cellulose fiber.
- E. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.

2.05 CURING MATERIALS

- A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
- B. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309, Type I, Class B.
- C. Moisture-Retaining Sheet: ASTM C171.
 - 1. Polyethylene film, white opaque, minimum nominal thickness of 4 mil, 0.004 inch.
 - 2. White-burlap-polyethylene sheet, weighing not less than 3.8 ounces per square yard.
- D. Water: Potable, not detrimental to concrete.

2.06 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 5,000 psi (35 MPa) at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than 5,000 psi (35 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.07 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI PRC-211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI SPEC-301.

1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended or required by manufacturer.

2.08 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M.
1. For mixer capacity of 1 cu yd or smaller, mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
 2. For mixer capacity larger than 1 cu yd, increase mixing time by 15 seconds for each additional 1 cu yd.
 3. Provide batch ticket for each batch discharged and used in the Work, indicating project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.
- B. Transit Mixers: Comply with ASTM C94/C94M, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- C. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that forms are clean and free of rust before applying release agent.
- B. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- C. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
 2. Use latex bonding agent only for non-load-bearing applications.
- D. Interior Slabs on Grade: Install vapor barrier under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

3.02 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

- A. Comply with requirements of ACI SPEC-301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.
- B. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.
- C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.03 PLACING CONCRETE

- A. Place concrete in accordance with ACI PRC-304.
- B. Place concrete for floor slabs in accordance with ACI PRC-302.1.
- C. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- D. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.
- E. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- F. Ensure reinforcement, inserts, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- G. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- H. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- I. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.04 SLAB JOINTING

- A. Locate joints as indicated on drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
- D. Grooved Contraction Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

E. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

3.05 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. An independent testing agency, as specified in Section 01 4000, will inspect finished slabs for compliance with specified tolerances.
- B. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values for a randomly trafficked floor surface:
 1. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
- C. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155 (ASTM E1155M), within 48 hours after slab installation; report both composite overall values and local values for each measured section.
- D. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.06 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Concrete Slabs: Finish to requirements of ACI PRC-302.1 and as follows:
 1. Other Surfaces to Be Left Exposed: Trowel as described in ACI PRC-302.1, minimizing burnish marks and other appearance defects.

3.07 CURING AND PROTECTION

- A. Comply with requirements of ACI PRC-308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Surfaces Not in Contact with Forms:
 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-fog spray, or saturated burlap.
 2. Final Curing: Begin after initial curing but before surface is dry.
 - a. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

3.08 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.

- C. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure one composite sample of test cylinders. Obtain sample for every 100 cubic yards or less of each class of concrete placed.
1. When frequency of testing provides fewer than five compressive strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Cast and field cure four 6x12 or five 4x8 cylinder specimens for each composite sample.
 3. Test one 6x12 or 4x8 laboratory-cured cylinder at 7 days and one set of two 6x12 or three 4x8 cylinders at 28 days. One cylinder will be retained in reserve for later testing if required.
 4. For concrete mixes with 56 day strengths, test one 6x12 or 4x8 laboratory-cured cylinder at 7 days and one set of two 6x12 or three 4x8 cylinders at 56 days. One cylinder will be retained in reserve for later testing if required.
 5. A compressive strength test shall be the average compressive strength from a set of cylinders obtained from same composite sample and tested at age indicated.
 6. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive strength tests equals or exceeds specified compressive strength and no compressive strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
- D. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- E. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M. Slump shall be tested at point of placement.
- F. Air Content: ASTM C321, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
- G. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.
- H. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

3.09 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive strength tests shall contain project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
1. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.

2. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 3. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.10 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.
- B. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION

**SECTION 03 3500
CONCRETE FLOOR FINISHING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface treatments for concrete floors and slabs, including:
 - 1. Clear coatings and sealers.
 - 2. Polished concrete finish.
- B. Crack and joint filling of existing concrete floor slabs prior to finishing.

1.02 REFERENCE STANDARDS

- A. ANSI A326.3 - American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials.
- B. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- C. ASTM D4039 - Standard Test Method for Reflectance Haze of High-Gloss Surfaces.
- D. ASTM D5767 - Standard Test Method for Instrumental Measurement of Distinctness-of-Image (DOI) Gloss of Coated Surfaces.
- E. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- F. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
- G. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

1.03 DEFINITIONS

- A. DCOF: Dynamic (Wet) Coefficient of Friction.
- B. Slip-Resistant: Installed flooring surface which has a dynamic (wet) coefficient of friction (DCOF) of 0.42, minimum, as measured according to ANSI A326.3.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with concrete floor placement and concrete floor curing.
- B. Preinstallation Meeting: Convene one week before starting floor polishing work of this Section.
 - 1. Convene under general provisions of Section 01 7000.
 - 2. Conduct a review of procedures required to produce specified work results.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.

- C. Product Data: Manufacturer's published data and installation instructions for concrete polishing system and finishing products, including manufacturer's installation instructions, information on compatibility of different products, and limitations.
- D. Manufacturer's Certificate - Polished Finish System: Provide letter of certification from manufacturer stating that installer is a certified applicator and is familiar with manufacturers required procedures for application of specified finish system
 - 1. Slip-Resistance: Certify that specified floor finish system, when installed, comply with specified requirements for slip-resistance.
- E. Manufacturer's Instructions - Polished Finish System: Indicate manufacturer's product and system name, application specifications and procedures, and conditions requiring special attention or procedures under indicated project conditions.
- F. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

1.06 QUALITY ASSURANCE

- A. For slabs indicated to receive concrete polishing system, do not proceed with concrete polishing unless manufacturer's representative and specialized equipment is present for every day of placement.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications - Polished Finish: Company specializing in performing work of the type specified and with minimum three years of documented experience and approved by manufacturer.

1.08 MOCK-UP

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Mock-up: For polished finish, construct mock-up area under conditions similar to those that will exist during application, with coatings applied.
 - 1. Mock-Up Size: 10 feet square.
 - 2. Locate where directed.
 - 3. Mock-up may remain as part of the work.

1.09 DELIVERY, STORAGE, AND HANDLING

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

1.10 FIELD CONDITIONS

- A. Special Protection of Floor Finish Substrates:
 - 1. Provide special protection of concrete surfaces to receive specified floor finishes to prevent detrimental damage that prevents proper application of floor finishes and production of intended results; also comply with other protection requirements where specified in related specification Sections.
 - 2. Provide temporary and removable protective coverings to completely protect floor surfaces.
 - 3. Protect floors, stairs, and other surfaces prepared under other Sections from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
 - 4. Control activity in work area to prevent detrimental damage.
 - 5. Repair detrimental damage to satisfaction of Architect and Owner, at no additional cost to Owner.

- B. 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.
- C. Do not finish floors until interior heating system is operational.
- D. Maintain ambient temperature of 50 degrees F minimum.
- E. Polished Finish System: Comply with system manufacturer's written instructions for ambient temperature and other conditions affecting installation performance.
 - 1. Concrete must be cured minimum 14 days, or as otherwise directed by system manufacturer before commencement of system application.

PART 2 PRODUCTS

2.01 CONCRETE FLOOR FINISH APPLICATIONS

- A. Slip-Resistance: Where specified, installed floor finishes must be slip resistant as defined in this Section, in scheduled locations, paths of egress, and other locations required by applicable code.
- B. Unless otherwise indicated, all exposed concrete floors are to be finished using low gloss concrete sealer.
 - 1. Include specified plastic aggregate additive to produce slip-resistance on sealed floor surfaces where specifically scheduled on Drawings.
- C. Polished Finish:
 - 1. Applications: Where scheduled on Drawings.

2.02 FLOOR COATINGS

- A. Low Gloss Clear Sealer: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C1315, Type 1, Class A.
 - 1. Vehicle: Water-based.
 - 2. Solids by Mass: 25 percent, minimum.
 - 3. VOC Content: OTC compliant.
 - 4. Acceptable Products:
 - a. Kaufman Products Inc.; Krystal 25 OTC, or Krystal 25 Emulsion: www.kaufmanproducts.net/#sle.
 - b. SpecChem, LLC; Cure and Seal WB 25: www.specchemllc.com/#sle.
 - c. W. R. Meadows, Inc.; Decra-Seal OTC: www.wrmeadows.com/#sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.03 COATING ADDITIVES

- A. Plastic Aggregate: Finely ground polymer for addition to coatings for slip resistance.
 - 1. Acceptable Products:
 - a. Dayton Superior Corporation; Grip Aid: www.daytonsuperior.com/#sle.
 - b. Euclid Chemical Company; EUCO GRIP: www.euclidchemical.com/#sle.
 - c. SpecChem, LLC; Surface Grip: www.specchemllc.com/#sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.04 POLISHED CONCRETE FINISH SYSTEM

- A. Polished Concrete System: Materials, equipment, and procedures designed and furnished by a single manufacturer to produce dense polished concrete of specified sheen. Materials and process include grinding, application of hardener, densifier, stain guard, surface honing, polishing, application of a micro-filming coating, and final polishing.
1. Slip-Resistance: Installed polished flooring must be slip resistant as defined in this Section, in scheduled locations, paths of egress, and other locations required by applicable code.
 2. Concrete Mix for Polished Floor Finish: Confirm polished concrete system manufacturer's requirements for concrete mix design specified in Section 03 3000; make necessary adjustments to specified mix design, if necessary, to comply with accepted manufacturer's requirements.
 3. Concrete Floor Finishing: Confirm polished concrete system manufacturer's requirements for concrete surface finishing as specified in Section 03 3000; specified polishing system may require special curing and finishing methods including but not limited to wet curing and laser screeding to achieve required levelness F(L) and flatness F(F) tolerances.
 4. Acceptable Systems:
 - a. Ameripolish, Inc; Ameripolish Polished Concrete System: www.ameripolish.com/#sle.
 - b. Curecrete Distribution, Inc.; RetroPlate: www.curecrete.com/#sle.
 - c. Euclid Chemical Company; DOUBLE DIAMOND POLISHED CONCRETE FLOOR SYSTEMS: www.euclidchemical.com/#sle.
 - d. Green Umbrella Architectural Concrete Systems; Green Umbrella Concrete Polishing: www.greenumbrellasystems.com/#sle.
 - e. Bomanite Corporation; VitraFlor Custom Polishing System: www.bomanite.com.
 - f. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that floor surfaces are acceptable to receive the work of this Section, in accordance with recommendations of manufacturers of each specified floor finish.
- B. Cementitious Subfloor Surfaces: Verify that substrates are ready for floor coating installation by testing for moisture and alkalinity (pH).
1. Test as Follows:
 - a. Alkalinity (pH): ASTM F710.
 - b. Internal Relative Humidity: ASTM F2170.
 - c. Moisture Vapor Emission: ASTM F1869.
 2. Obtain instructions if test results are not within limits recommended by floor coating manufacturer.

3.02 PREPARATION

- A. Transparent Floor Finishes: Patch flaws in existing and new concrete floors, including but not limited to cracks, minor spalling along existing joint edges, abrasions, and similar flaws in existing floor surfaces. Use methods and materials suitable for specified finishes and acceptable to manufacturer of affected floor finish product or system.
- B. Before proceeding with floor finishing, verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes, and acceptable to floor finish manufacturer(s).

3.03 INSTALLATION - GENERAL

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

3.04 COATING APPLICATION

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

3.05 CONCRETE POLISHING

- A. Execute using materials, equipment, and procedures specified by manufacturer, using manufacturer approved installer to achieve specified appearance qualities.
 - 1. Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.
 - 2. Machine grind floor surfaces to receive polished finishes level and smooth and to depth required to reveal aggregate as specified.
 - 3. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
 - 4. Continue polishing with progressively finer-grit diamond polishing pads to gloss level, to achieve specified requirements.
- B. Aggregate Exposure and Sheen: Level 2; polished with images of objects being reflected as described below in accordance with ASTM D4039 and ASTM D5767:
 - 1. Low Sheen Finish: 400 grit; matte appearance with or without slight reflectance of images from side lighting.

3.06 PROTECTION

- A. Protect polished finished surfaces as required and as recommended by manufacturer of polishing system.
- B. Provide special protection of concrete surfaces which have received specified floor finishes to prevent detrimental damage to finished flooring surfaces; also comply with other protection requirements where specified in related specification Sections.
- C. Provide protective coverings to completely protect floor surfaces.
- D. Control activity in work area to prevent detrimental damage.
- E. Repair detrimental damage to satisfaction of Architect and Owner, at no additional cost to Owner.

END OF SECTION

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**SECTION 03 4513
PRECAST ARCHITECTURAL CONCRETE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Architectural precast concrete (cast stone); decorative, non-structural units, including:
 - 1. Exterior wall units, including window sills and column caps.
 - 2. Other items indicated on Drawings.

1.02 REFERENCE STANDARDS

- A. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
- B. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- C. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
- D. ASTM C150/C150M - Standard Specification for Portland Cement.
- E. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
- F. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
- G. ASTM C1364 - Standard Specification for Architectural Cast Stone.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Include elevations, dimensions, layouts, profiles, cross sections, reinforcement, exposed faces, arrangement of joints, anchoring methods, anchors, and piece numbers.
- C. Full-Size Samples for Review:
 - 1. Basic Shapes: One of each.
 - 2. Accent, Trim and Specialty Shapes: One of each.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. A firm with a minimum of 5 years experience producing precast concrete of types required for project.
 - 2. Adequate plant capacity to furnish quality, sizes, and quantity of precast concrete required without delaying progress of the work.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components secured to shipping pallets and protected from damage and discoloration. Protect corners from damage.
- B. Number each piece individually to match shop drawings and schedule.

- C. Store components and installation materials in accordance with manufacturer's instructions.
- D. Store components on pallets with nonstaining, waterproof covers. Ventilate under covers to prevent condensation. Prevent contact with dirt.
- E. Protect components during handling and installation to prevent chipping, cracking, or other damage.
- F. Store mortar materials where contamination can be avoided.
- G. Schedule and coordinate production and delivery of components with unit masonry work to optimize on-site inventory and to avoid delaying the work.

PART 2 PRODUCTS

2.01 ARCHITECTURAL PRECAST CONCRETE

- A. Precast Concrete: Architectural concrete product manufactured to simulate appearance of natural stone, complying with ASTM C1364.
 - 1. Compressive Strength: As specified in ASTM C1364; calculate strength of pieces to be field cut at 80 percent of uncut piece.
 - 2. Freeze-Thaw Resistance: Demonstrated by laboratory testing in accordance with ASTM C1364.
 - 3. Surface Texture: Fine grained texture, with no bugholes, air voids, or other surface blemishes visible from distance of 20 feet.
 - 4. Color: Selected by Architect from manufacturer's full range.
- B. Shapes: Provide shapes indicated on Drawings.
 - 1. Variation from Any Dimension, Including Bow, Camber, and Twist: Maximum of plus/minus 1/8 inch or length divided by 360, whichever is greater, but not more than 1/4 inch.
 - 2. Unless otherwise indicated on drawings, provide:
 - a. Wash or slope of 1:12 on exterior horizontal surfaces.
 - b. Drips on projecting components, wherever possible.
 - c. Raised fillets at back of sills and at ends to be built in.
- C. Reinforcement: Provide reinforcement as required to withstand handling and structural stresses; comply with ACI 318.
 - 1. Pieces More than 24 inches in Any Dimension: Provide full length two-way reinforcement of cross-sectional area not less than 0.25 percent of unit cross-sectional area.

2.02 MATERIALS

- A. Portland Cement: ASTM C150/C150M.
 - 1. For Units: Type I or II, white or gray to be determined.
 - 2. For Mortar: Type I or II, except Type III may be used in cold weather.
- B. Coarse Aggregate: ASTM C33/C33M, except for gradation; granite, quartz, or limestone.
- C. Fine Aggregate: ASTM C33/C33M, except for gradation; natural or manufactured sands.
- D. Admixtures: ASTM C494/C494M.
- E. Water: Potable.
- F. Reinforcing Bars: ASTM A615/A615M, Grade 40 (40,000 psi), deformed bars, plain.

- G. Mortar: Portland cement-lime, ASTM C270 Type N.
- H. Cleaner: General-purpose cleaner designed for removing mortar and grout stains, efflorescence, and other construction stains from new masonry surfaces without discoloring or damaging masonry surfaces; approved for intended use by cast stone manufacturer and by cleaner manufacturer for use on cast stone and adjacent masonry materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine construction to receive precast concrete components. Notify Architect if construction is not acceptable.
- B. Do not begin installation until unacceptable conditions have been corrected.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions, and as indicated on Drawings.
- B. Install precast concrete components in conjunction with masonry, complying with requirements of Section 04 2200.13.

3.03 TOLERANCES

- A. Joints: Make all joints 3/8 inch, except as otherwise detailed.
- B. Installation Tolerances:
 - 1. Variation from Plumb: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet or more.
 - 2. Variation from Level: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet, or 3/8 inch maximum.
 - 3. Variation in Joint Width: Not more than 1/8 inch in 36 inches or 1/4 of nominal joint width, whichever is less.
 - 4. Variation in Plane Between Adjacent Surfaces (Lipping): Not more than 1/16 inch difference between planes of adjacent units or adjacent surfaces indicated to be flush with units.

3.04 REPAIR

- A. Repair chips and other surface damage noticeable when viewed in direct daylight at 20 feet.
- B. Repair with matching touch-up material provided by the manufacturer and in accordance with manufacturer's instructions.
- C. Repair methods and results subject to Architect 's approval.

3.05 CLEANING

- A. Clean completed exposed precast concrete after mortar is thoroughly set and cured.
 - 1. Wet surfaces with water before applying cleaner.
 - 2. Apply cleaner in accordance with manufacturer's instructions.
 - 3. Remove cleaner promptly by rinsing thoroughly with clear water.
 - 4. Do not use acidic cleaners.

3.06 PROTECTION

- A. Protect completed work from damage.
- B. Clean, repair, or restore damaged or mortar-splashed work to condition of new work.

END OF SECTION

SECTION 04 2200.13
CONCRETE MASONRY UNIT VENEER

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Veneer masonry assemblies, including:
 - 1. Concrete masonry veneer.
- B. Accessory materials, including:
 - 1. Mortar.
 - 2. Reinforcement and anchorage.
 - 3. Flashings.
 - 4. Lintels.
 - 5. Other specified accessories.

1.02 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- C. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
- D. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement.
- E. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- F. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units.
- G. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
- H. ASTM C150/C150M - Standard Specification for Portland Cement.
- I. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
- J. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
- K. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
- L. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete.
- M. BIA Technical Notes No. 18A - Accommodating Expansion of Brickwork.
- N. BIA Technical Notes No. 20 - Cleaning Brickwork.
- O. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Direct and coordinate placement of metal anchors supplied for installation under other Sections.

- B. Preinstallation Meeting: Convene meeting one week before starting work of this Section.
 - 1. Convene under general provisions of Section 01 7000.
 - 2. Require attendance by all relevant installers.
 - 3. Require attendance of parties directly affecting work of this Section.
 - 4. Review conditions of installation, installation procedures, and coordination with related work.
- 1.04 SUBMITTALS
- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
 - B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.
 - C. Verification Samples: Submit four samples of specified masonry units to illustrate color, texture, and extremes of color range.
- 1.05 QUALITY ASSURANCE
- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
 - B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
 - C. Basis of Design: Specifications are based on unit masonry types by specified basis of design manufacturer and product(s). Unit masonry types manufactured by other acceptable manufacturers are permitted, subject to compliance with specified requirements; and provided that deviations in design, weight, color, texture/pattern, and profile are minor, and do not detract substantially from the indicated design intent.
 - 1. Comply with requirements specified in Section 01 4000 and Section 01 6000.
- 1.06 MOCK-UPS
- A. See Section 01 4000 - Quality Requirements for additional requirements.
 - B. Mock-up: Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar, accessories, structural backup, wall openings, flashings (with lap joint, corner, and end dam), wall insulation, and full weather barrier system in mock-up.
 - 1. Locate where directed.
 - 2. Mock-up may remain as part of work.
- 1.07 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

- 2.01 CONCRETE MASONRY UNITS (CMU)
- A. General: Comply with recycled content and recyclable materials product requirements specified in Section 01 6000 - Product Requirements.
 - B. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depth of 4 inches.
 - 2. Special Shapes: Provide nonstandard blocks configured for corners.

3. Nonloadbearing Veneer Units: ASTM C129.
 - a. Hollow block, as indicated.
 - b. Normal weight.
 - c. Exposed Face Texture: Split face.
 - d. Basis of Design Manufacturer: Confirm before procurement; design intent is to match existing.
 - 1) Anchor Block Co.; Santa Fe #506: www.anchorblock.com.
 - 2) Substitutions: See Section 01 6000 - Product Requirements.

2.02 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I.
 1. Not more than 0.60 percent alkali.
 2. Hydrated Lime: ASTM C207, Type S.
 3. Mortar Aggregate: ASTM C144.
 4. Grout Aggregate: ASTM C404.
- B. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.
 1. Color(s): As selected by Architect from manufacturer's full range.
 2. Acceptable Manufacturers:
 - a. Davis Colors, a division of Venator Materials PLC: www.daviscolors.com/#sle.
 - b. Lambert Corporation: www.lambertusa.com/#sle.
 - c. Solomon Colors: www.solomoncolors.com/sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- C. Water: Clean and potable.
- D. Admixtures: Not permitted unless specified, or requested by Contractor in writing and approved in writing by Architect.

2.03 REINFORCEMENT AND ANCHORAGE

- A. Single Wythe Joint Reinforcement: ASTM A951/A951M.
 1. Type: Truss.
 2. Material: ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M Class 3.
 3. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.
- B. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A153/A153M 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: Triangular shape, 0.1875 inch thick.
 3. Vertical Adjustment: Not less than 3-1/2 inches.
 4. Acceptable Product:
 - a. Wire-Bond; #1004X Type IIIIX Screw On Veneer Anchor: www.wirebond.com.
 - b. Substitutions: See Section 01 6000 - Product Requirements.

2.04 FLASHINGS

- A. Stainless Steel/Polymer Fabric Drainage Plane Flashing: ASTM A240/A240M; 2 mil type 304 stainless steel sheet bonded between one sheet of polymer fabric and one sheet of non-woven drainage material.
 - 1. Accessories: Provide all accessory components required by manufacturer for complete system, including termination bars, seaming tapes, and similar components.
 - 2. Acceptable Manufacturer:
 - a. York Manufacturing, Inc.; Flash-Vent SS: www.yorkmfg.com.
 - b. Substitutions: See Section 01 6000 - Product Requirements.
- B. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membrane and adhesives.

2.05 ACCESSORIES

- A. 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. Acceptable Manufacturer:
 - 1) York Manufacturing, Inc.; Weep-Net: www.yorkmfg.com/#sle.
 - 2) Substitutions: See Section 01 6000 - Product Requirements.
- B. Weeps and Cavity Vents: Molded PVC grilles, insect resistant.
 - 1. Width: Match specified mortar joint thickness; 3/8 inch, unless otherwise indicated.
 - 2. Height: Match height of applicable masonry unit, plus 3/8 inch.
 - 3. Depth: Match depth of applicable masonry unit, plus 1/4 inch.
 - 4. Color(s): As selected by Architect from manufacturer's full range.
- C. Drainage Fabric: Polyester or polypropylene mesh bonded to a water and vapor-permeable fabric.
 - 1. Acceptable Manufacturer:
 - a. York Manufacturing, Inc.; Weep Armor Weep Vent Protection: www.yorkmfg.com.
 - b. Substitutions: See Section 01 6000 - Product Requirements.
- D. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.
 - 1. Acceptable Product:
 - a. ProSoCo, Inc.; Safety Clean: www.prosoco.com.
 - b. Substitutions: See Section 01 6000 - Product Requirements.

2.06 LINTELS

- A. Steel Lintels: Specified in Section 05 5000.

2.07 MORTAR MIXES

- 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. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.01 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.
- D. Verify that weather barrier is installed according to Section 07 2500.

3.02 PREPARATION

- A. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COLD AND HOT WEATHER REQUIREMENTS

- A. Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

3.04 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Concrete Masonry Units:
 - 1. Bond: Running.
 - 2. Coursing: One unit and one mortar joint to equal 8 inches.
 - 3. Mortar Joints: Concave.

3.05 PLACING AND BONDING

- A. Lay hollow masonry units with face shell bedding on head and bed joints.
- B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- C. Remove excess mortar and mortar smears as work progresses.
- D. Interlock intersections and external corners.
- E. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- F. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.06 WEEPS/CAVITY VENTS

- A. Install weeps in veneer and cavity walls at maximum 24 inches on center horizontally above through-wall flashing, above shelf angles and lintels, at bottom of walls, and rowlock/belt courses where indicated, unless otherwise specified.
 - 1. Space weeps maximum 16 inches on center where through-wall flashings are installed directly below rowlock courses, belt courses, precast concrete courses, and similar locations.

- B. Install cavity vents in veneer and cavity walls at maximum 32 inches on center horizontally below shelf angles and lintels and near top of walls.
 - C. Position weep/cavity vent tabs to extend maximum 1/8 inch beyond outside face of veneer masonry, but not less than 1/16 inch.
- 3.07 CAVITY MORTAR CONTROL
- A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.
 - B. Install drainage fabric or 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.
- 3.08 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER
- A. Stud and Sheathing 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.
- 3.09 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 at least 12 inches, minimum, to form watertight pan at non-masonry construction. Use continuous lengths of flashing material in each individual opening wherever possible; minimize seams.
 2. Form end dams at sides of flashing openings as recommended by flashing manufacturer for indicated conditions of installation and service.
 3. Seal top edge of flashings with manufacturer's required termination bar and continuous sealant bead at top edge of termination bar.
 4. Install 1 inch fillet bead of liquid membrane or mastic at changes in plane to fully support membrane at those locations.
 5. Remove or cover protrusions or sharp edges that could puncture flashings.
 6. Tape seal butted seams and penetrations of flashing before covering with mortar.
 - B. Install manufactured through-wall flashings in conjunction with manufacturer's required accessories, including web spacer/bridge units, termination bars, drainage fabrics, and similar items to produce a complete, properly functioning installation.
 - C. Extend metal flashings with straight edge to within 1/8 inch of exterior face of masonry veneer; do not extend flashing edge beyond outside face of masonry veneer.
- 3.10 LINTELS
- A. Install loose steel lintels over openings.
 - B. Maintain minimum 4 inch bearing on each side of opening, unless otherwise indicated on Drawings.
- 3.11 CONTROL AND EXPANSION JOINTS
- A. General: Comply with general requirements of BIA Technical Notes No. 18A.

- B. Size and locate control joints as indicated on Drawings; if not shown, 3/8 inch wide; verify all joint locations with Architect.
 - 1. Spacing - General: Maximum 25 feet, except as otherwise indicated on Drawings for closer spacing or other conditions as specified below.
 - a. Provide sealed expansion joint at all internal corners of only non-structural masonry veneer, whether or not specifically noted or detailed.
 - b. Provide sealed expansion joint within 15 feet of external corners of only non-structural masonry veneer.
 - C. Do not continue horizontal joint reinforcement through control or expansion joints.
 - D. Locate expansion joints as indicated on Drawings.
- 3.12 BUILT-IN WORK
- A. As work progresses, install built-in metal door 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. Do not build into masonry construction organic materials that are subject to deterioration.
- 3.13 TOLERANCES
- A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
 - B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft 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 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
 - E. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/8 inch, plus 1/8 inch.
- 3.14 CUTTING AND FITTING
- A. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.
- 3.15 CLEANING
- A. General: Comply with general requirements of BIA Technical Notes No. 20.
 - B. Remove excess mortar and mortar droppings.
 - C. Replace defective mortar. Match adjacent work.
 - D. Clean soiled surfaces with specified cleaning solution, at low pressure or by hand methods only; do not introduce excessive moisture into masonry wall surfaces during cleaning operations.
 - E. Use non-metallic tools and stiff brushes in cleaning operations.

[See next page]

3.16 PROTECTION

- A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.
 - 1. Install required protection of installed work at the end of each work day.

END OF SECTION

SECTION 05 1200
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Structural steel framing members.
- B. Base plates.
- C. Grouting under base plates.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. AISC (MAN) - Steel Construction Manual; 2023.
- B. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges; 2022.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- E. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
- F. ASTM A563/A563M - Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric); 2021a.
- G. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; 2021, with Editorial Revision.
- H. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2022.
- I. ASTM F436/F436M - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions; 2019.
- J. ASTM F959/F959M - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series; 2017a.
- K. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2020.
- L. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2023.
- M. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- N. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- O. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- P. RCSC (HSBOLT) - Specification for Structural Joints Using High-Strength Bolts; Research Council on Structural Connections; 2020.

1.04 COORDINATION

- A. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.05 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.06 ACTION SUBMITTALS

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

B. Shop Drawings:

1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
2. Connections.
3. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.

1.07 INFORMATIONAL SUBMITTALS

A. Mill Test Reports: Indicate structural strength, destructive test analysis and non-destructive test analysis.

B. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.

C. Fabricator's Qualification Statement.

D. Installer qualification data.

E. Product Test Reports for the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shop primers
5. Nonshrink grout

F. Source quality-control reports.

G. Field quality-control reports and special inspection reports.

1.08 QUALITY ASSURANCE

A. Fabricate structural steel members in accordance with AISC (MAN) "Steel Construction Manual."

B. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU.

1. If a fabricator is not AISC-Certified, additional documentation and shop inspection according to AISC 360 Chapter N and AISC 431 Chapter J, and as determined by the structural engineer of record will be required.

C. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

D. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and no more than 12 months before start of scheduled welding work.

E. Comply with applicable provisions of the following:

1. AISC 303
2. AISC (MAN)
3. RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts."

1.09 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged

materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

2.02 MATERIALS

- A. Steel Angles, Plates, and Channels: ASTM A36/A36M.
- B. Steel W Shapes and Tees: ASTM A992/A992M or ASTM A572/A572M Grade 50 (345).
- C. Cold-Formed Structural Tubing: ASTM A500/A500M, Grade C.
- D. Pipe: ASTM A53/A53M, Grade B, Finish black.
- E. High-Strength Structural Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, with matching compatible ASTM A563/A563M nuts and ASTM F436/F436M washers.
- F. Tension Control Bolts: Twist-off type; ASTM F3125/F3125M, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon steel nuts, and hardened carbon-steel washers.
- G. Headed Anchor Rods: ASTM F1554 Grade 36, plain or zinc coated, straight configuration, with matching ASTM A563/A563M nuts and ASTM F436/F436M Type 1 washers.
- H. Threaded Rods: ASTM A36/A36M, plain or zinc coated, with matching ASTM A563/A563M nuts and ASTM F436/F436M Type 1 washers
- I. Load Indicator Washers: Provide washers complying with ASTM F959/F959M at connections requiring high-strength bolts.
- J. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- K. Grout: ASTM C1107/C1107M; Non-shrink; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
- L. Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.03 FABRICATION

- A. Shop fabricate to greatest extent possible.
1. Fabricate beams with rolling camber up.
 2. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.

3. Mark and match-mark materials for field assembly.
 4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
- F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2.

2.04 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts."
1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.05 FINISH

- A. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, embedded in concrete or mortar, high strength bolted with slip-critical connections, or galvanized.
- B. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- C. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.06 SOURCE QUALITY CONTROL

- A. Owner will engage a qualified testing agency to provide shop testing and inspection of structural steel.
- B. High-Strength Bolts: Provide testing and verification of shop-bolted connections in accordance with RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts."
- C. Welded Connections: Visually inspect all shop-welded connections according to AWS D1.1/D1.1M.
- D. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.02 ERECTION

- A. Erect structural steel in compliance with AISC 303.
- B. Allow for erection loads and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- C. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
- D. Do not field cut or alter structural members without approval of Architect.
- E. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- F. Splice members only where indicated.
- G. Baseplates and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
- H. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.03 TOLERANCES

- A. Maintain erection tolerances of structural steel within AISC 303.

3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with AISC 303 and AISC (MAN) for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, where indicated, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

3.05 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.
- B. High-Strength Bolts: Provide testing and verification of field-bolted connections in accordance with RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts."
- C. Welded Connections: Visually inspect all field-welded connections according to AWS D1.1/D1.1M.
 - 1. Inspect joint geometry for fit-up prior to welding.
 - 2. Full penetration groove welds shall be ultrasonically tested.
 - 3. Inspect pre-heat, post-heat and surface preparation between passes. Verify size and length of fillet welds.

3.06 REPAIRS AND PROTECTION

- A. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- B. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

END OF SECTION

SECTION 05 4001
COLD-FORMED METAL FRAMING BEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formed steel stud exterior wall framing.

1.02 REFERENCE STANDARDS

- A. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.
- B. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (2020).
- C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- D. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- E. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.
- F. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.
- G. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.
- H. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2018, with Errata (2022).

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by affected installers.

1.04 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on cold-formed steel structural members; include material descriptions and base steel thickness.
- C. Product Data: Provide manufacturer's data on factory-made connectors and mechanical fasteners, showing compliance with requirements.
- D. Product Data: For lateral-force resisting systems, provide product data sheets on hold-down, showing compliance with requirements.
- E. 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 for panelized walls.
- F. Inspection Reports: Provide material verification Inspection Reports in accordance with requirements of AISI S240.
- G. Inspection Reports: Provide Inspection Reports for welding, mechanical fastening, and cold-formed steel light-frame construction in accordance with requirements of AISI S240 and structural drawings.
- H. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before the start of scheduled welding work.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Product Certificates: For each type of code-compliance certification for studs and tracks.
- D. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.
 - 1. Steel sheet.
 - 2. Expansion anchors.
 - 3. Power-actuated anchors.
 - 4. Mechanical fasteners.
 - 5. Vertical deflection clips.
 - 6. Miscellaneous structural clips and accessories.
- E. Evaluation Reports: For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
- F. QUALITY ASSURANCE
 - 1. See Section 01 4000 - Quality Requirements for additional requirements.
 - 2. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.
 - 3. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M and dated no more than 12 months before start of scheduled welding work.
 - 4. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Material and Product Requirements Criteria: AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
 - 1. Corrosion Protection Coating Designation: CP 60 in accordance with AISI S240.

2.02 STRUCTURAL FRAMING COMPONENTS

- A. Wall Studs and Track Sections: AISI S240; c-shaped studs and u-shaped track sections in stud-matching nominal width and compatible height.

2.03 CONNECTIONS

- A. Performance Requirements: Provide connections in compliance with requirements of AISI S240.
- B. Fixed Connections: Provide nonmovement devices for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.
- C. Bridging Connections: Provide mechanical load-transferring devices that accommodate wind load torsion and weak axis buckling induced by axial compression loads. Provide bridging connectors as required.

2.04 MISCELLANEOUS CONNECTIONS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot-dip galvanized per ASTM A153/A153M.
- B. Anchorage Devices: Powder actuated.

C. Welding: Comply with AWS D1.1/D1.1M.

2.05 ACCESSORIES

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness as indicated on structural drawings or as determined for conditions encountered; finish to match framing components.
- B. Galvanizing Repair: Touch up bare steel with zinc-rich paint in compliance with ASTM A780/A780M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that abutting building framing components are ready to receive work.
- B. Verify field measurements and adjust installation as required.

3.02 PREPARATION

- A. Exterior and bearing studs provide:
 - 1. For gaps between wall bottom track and top of foundation [1/4 inch] or greater, level substrate with loadbearing shims or grout between track and foundation.
 - 2. Pre-compress studs in the track to 1/8" gap maximum.
 - 3. Provide deeper web track to provide full stud bearing.

3.03 INSTALLATION - GENERAL

- A. Install structural members and connections in compliance with ASTM C1007.

3.04 INSTALLATION OF STUDS

- A. Install wall studs plumb and level.
- B. Construct corners using minimum of three studs.
- C. Install load-bearing studs full length in one piece. Splicing of studs is not permitted.
- D. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- E. Install intermediate studs above and below openings to align with wall stud spacing.
- F. Touch-up field welds and damaged corrosion protected surfaces with primer.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide inspections for welding, mechanical fastening, and cold-formed steel light-frame construction in accordance with requirements of AISI S240.
- C. Provide additional inspections as indicated on structural drawings.
- D. Coordination of Other Tests and Inspections: Owner will employ independent testing agency to perform field tests and inspections and prepare test reports.

3.06 TOLERANCES

- A. Studs - Vertical Alignment (Plumbness): 1/960 of span or 1/8 inch in 10 ft, in accordance with ASTM C1007.
- B. Studs - Maximum Variation from True Position: 1/8 inch in accordance with ASTM C1007.
- C. Stud Spacing: 1/8 inch from the designated spacing, provided that the cumulative error does not exceed the requirements of the finishing materials in accordance with ASTM C1007.

END OF SECTION

**SECTION 05 5000
METAL FABRICATIONS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop fabricated steel items, including:
 - 1. Bollards.
 - 2. Loose lintels.
 - 3. Other items as specified in this Section and as indicated on Drawings.

1.02 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- C. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- D. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- E. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
- F. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- G. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
- H. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- I. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
- J. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer.
- K. SSPC-SP 2 - Hand Tool Cleaning.

1.03 SUBMITTALS

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

1.04 QUALITY ASSURANCE

- A. Fabricator Qualifications:
 - 1. A company specializing in manufacturing products specified in this Section, with not less than ten years of documented experience.

PART 2 PRODUCTS

2.01 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. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.
- F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- G. Shop and Touch-Up Primer: SSPC-Paint 15; fabricator's standard.

2.02 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Continuously seal joined members by continuous welds.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
 - 1. Comply with NOMMA voluntary guidelines for joint finishes; Finish #2 - completely sanded joint, some undercutting and pinholes acceptable.
- E. Provide for thermal expansion/contraction of exterior metal railings and similar linear fabrications exceeding 30 feet in running length; and not closer than 24 inches from corners and intersections.
- F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- G. Tubular and Hollow Fabrications: Fabricate with open ends or 1/8 inch diameter drilled holes for moisture weepage, unobtrusively located and concealed from view wherever possible.
- H. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FABRICATED ITEMS

- A. Provide and install items shown on Drawings with anchorage and attachments necessary for installation.
- B. The following is a list of principal items only. Refer to Drawing details for items not specifically scheduled:
 - 1. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.
 - a. Color: Paint Safety Yellow (RAL 1023) or as specified by Owner requirements.
 - 2. Lintels: As detailed; prime paint finish. Supply to applicable unit masonry Section for installation.
 - 3. Firestopping Sleeves: Comply with requirements of Section 07 8400, and supply to that Section for installation; unfinished.

2.04 ACCESSORIES

- A. Non-Shrink Cementitious Grout: Premixed compound consisting of nonmetallic aggregate, cement, water reducing and plasticizing agents.
 - 1. Grout: Comply with ASTM C1107/C1107M.
 - 2. Height Change, Plastic State; when tested in accordance with ASTM C827/C827M:
 - a. Maximum: Plus 4 percent.
 - b. Minimum: Plus 1 percent.
 - 3. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch.
 - 4. Products containing aluminum powder are not permitted.
 - 5. Acceptable Flowable Products:
 - a. Dayton Superior Corporation; Sure-Grip High Performance Grout: www.daytonsuperior.com.
 - b. Five Star Products, Inc.; Five Star Fluid Grout 100: www.fivestarprouducts.com.
 - c. SpecChem, LLC; SC Precision Grout: www.specchemllc.com/#sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.05 FINISHES - STEEL

- A. General:
 - 1. Prepare surfaces to be primed in accordance with SSPC-SP 2, or as recommended by finish coating manufacturer.
 - 2. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Prime paint all steel items, unless otherwise specified.
 - 1. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
 - 2. Prime Painting: One coat.

2.06 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

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 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 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.

3.04 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 06 1000
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Structural dimension lumber framing.
- B. Sheathing.
- C. Preservative treated wood materials.

1.02 REFERENCE STANDARDS

- A. AF&PA WCD1 - Details for Conventional Wood Frame Construction; 2001.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- E. ASTM D2559 - Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions; 2012a (Reapproved 2018).
- F. ASTM D5456 - Standard Specification for Evaluation of Structural Composite Lumber Products; 2021, with Editorial Revision.
- G. ASTM F1667/F1667M - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples; 2021a.
- H. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. PS 2 - Performance Standard for Wood Structural Panels; 2018.
- J. PS 20 - American Softwood Lumber Standard; 2021.
- K. WCLIB (GR) - Standard Grading Rules for West Coast Lumber No. 17; 2018.
- L. WWPA G-5 - Western Lumber Grading Rules; 2021.

1.03 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- B. Evaluation Reports: For the following, from ICC-ES:
 - 1. Shear panels.
 - 2. Power-driven fasteners.
 - 3. Metal framing anchors.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Support stacked products to prevent deformation and to allow air circulation. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
1. Species: Douglas Fir-Larch, unless otherwise indicated.
 2. 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.
 3. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
 4. Factory mark each piece of lumber with grade stamp of grading agency.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Species: Lumber Species as indicated on drawings
1. Douglas fir-larch; Grading Agency: West Coast Lumber Inspection Bureau; WCLIB (GR) or Western Wood Products Association; WWPA G-5.
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: MC15 unless noted otherwise.
- D. Stud Framing (2 by 2 through 2 by 6):
1. Species: As indicated on drawings
 2. Grade: As Indicated on drawings.
- E. Joist, Rafter, and Small Beam Framing (2 by 6 through 4 by 16):
1. Species: As indicated on drawings
 2. Grade: As Indicated on drawings.
- F. Miscellaneous Framing
1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - a. Blocking.
 - b. Nailers.
 - c. Rooftop equipment bases and support curbs.
 - d. Cants.
 - e. Furring.
 - f. Grounds.
 2. Lumber: S4S, No. 2 or Standard Grade.
 3. Boards: Standard or No. 3, except as noted below.
 4. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
 5. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

6. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.03 STRUCTURAL COMPOSITE LUMBER

- A. Structural Composite Lumber: Factory fabricated beams, headers, and columns, of sizes and types indicated on drawings; structural capacity as published by manufacturer.
 1. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D5456 and manufactured with an exterior-type adhesive complying with ASTM D2559.
 - a. Extreme Fiber Stress in Bending, Edgewise: 2600 psi (17.9 MPa) for 12-inch nominal- (286-mm actual-) depth members.
 - b. Modulus of Elasticity, Edgewise: 2,000,000 psi (13 700 MPa).

2.04 ROOF SHEATHING: PS 2 TYPE, RATED STRUCTURAL I SHEATHING.

- A. Bond Classification: Exterior.
- B. Span Rating: 48.
- C. Performance Category: 5/8 PERF CAT.

2.05 WALL SHEATHING: PS 2 TYPE.

- A. Bond Classification: Exterior.
- B. Grade: Structural I Sheathing.
- C. Span Rating: 24.
- D. Performance Category: 1/2 PERF CAT.
- E. Edge Profile: Square edge.

2.06 ACCESSORIES

- A. Fasteners and Anchors:
 1. Metal and Finish: Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or of Type 304 stainless steel.
 2. Nails, Brads, and Staples: ASTM F1667/F1667M.
- B. Die-Stamped Connectors: Hot dipped galvanized steel, sized to suit framing conditions.
 1. General: Provide connectors indicated, including the following:
 - a. Joist Hangers: As indicated.
 - b. I-Joist Hangers: As indicated.
 - c. Top Flange Hangers: As indicated.
 - d. Post Bases: As indicated.
 - e. Joist Ties: As indicated.
 - f. Rafter Tie-Downs (Hurricane or Seismic Ties): As indicated.
 - g. Floor-to-Floor Ties: As indicated.
 - h. Hold-Downs: As indicated.
 2. Allowable design loads, as published by manufacturer, shall meet or exceed those of basis-of-design products. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.
 3. For contact with preservative treated wood in exposed locations, provide minimum G185 galvanizing complying with ASTM A653/A653M. Products at exterior locations shall be Stainless-Steel Sheet: ASTM A666, Type 316.

4. For interior locations unless otherwise indicated, provide minimum G90 (Z550) galvanizing complying with ASTM A653/A653M.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION - GENERAL

- A. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- C. Select material sizes to minimize waste.
- D. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

3.03 FRAMING INSTALLATION

- A. Framing Standard: Comply AF&PA WCD1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- C. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
- D. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
- E. Install structural members full length without splices unless otherwise specifically detailed.
- F. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes, AWC (WFCM) Wood Frame Construction Manual, and structural drawings
- G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. "Fastening Schedule," in ICC's International Building Code (ICC (IBC)).
 2. ICC-ES evaluation report for fastener.
- H. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.
- I. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists; use metal joist hangers unless otherwise detailed.

3.04 BLOCKING, NAILERS, FURRING AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches on center.
- D. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches on center with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches on center. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
 - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 square feet and to solidly fill space below partitions.
- E. Install furring level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- F. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal size furring horizontally and vertically at 24 inches on center.
- G. Furring to Receive Gypsum Board or Plaster Lath: Install 1-by-2-inch nominal size furring vertically at 16 inches on center.

3.05 INSTALLATION OF CONSTRUCTION PANELS

- A. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.
 - 1. Nail panels to framing as indicated in the drawings; staples are not permitted.
- B. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using nails, screws, or staples.
- C. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. 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.

3.06 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.07 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Rough Carpentry Testing and Inspection (unless noted otherwise in drawings):
 - 1. Verify material grades for all members and sheathing.
 - 2. Verify all member sizes, spacing and condition. Verify all nailing. Verify web stiffeners, if required.
 - 3. Verify all sheathing thickness, blocking and nailing.
 - 4. Verify anchor bolt size and spacing. Verify holddown installation.
 - 5. Verify hanger installation.

END OF SECTION

**SECTION 06 1053
MISCELLANEOUS ROUGH CARPENTRY**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-structural, miscellaneous rough carpentry items, including:
 - 1. Preservative treated wood materials.
 - 2. Fire retardant treated wood materials.
 - 3. Communications and electrical room mounting boards.
 - 4. Concealed wood blocking, nailers, and supports.

1.02 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. AWWA U1 - Use Category System: User Specification for Treated Wood.
- D. PS 1 - Structural Plywood.
- E. PS 20 - American Softwood Lumber Standard.

1.03 ADMINISTRATIVE REQUIREMENTS

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

1.04 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

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. Species: Douglas Fir-Larch or Hem-Fir.
 - 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.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Sizes: Nominal sizes as indicated on drawings, S4S.
- B. Moisture Content: S-dry or MC19.

- C. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.
- 2.03 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.
 - B. Other Applications:
 - 1. Plywood Concealed From View But Located Within Exterior Enclosure: PS 1, C-C Plugged or better, Exterior grade.
 - 2. Plywood Exposed to View But Not Exposed to Weather: PS 1, A-D, or better.
 - 3. Other Locations: PS 1, C-D Plugged or better.
- 2.04 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.
- 2.05 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: 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. Interior rough carpentry items are to be fire retardant treated.
 - c. Treat rough carpentry items as indicated on Drawings.
 - d. 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, minimum.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber in contact with roofing, flashing, or waterproofing.
 - c. Treat lumber in contact with masonry or concrete.
 - d. Treat lumber less than 18 inches above grade.
 - e. Treat lumber in other locations as indicated on Drawings.

PART 3 EXECUTION

3.01 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.

3.02 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 metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- C. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- D. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- E. Provide the following specific nonstructural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Handrails.
 - 3. Grab bars.
 - 4. Toilet and bath accessories.
 - 5. Wall-mounted door stops.
 - 6. Toilet partitions.
 - 7. Other items as indicated on Drawings.

3.03 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.

3.04 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.
- B. Allow preservative to dry prior to erecting members.

3.05 CLEANING

- A. Waste Disposal:
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

SECTION 06 1753
SHOP-FABRICATED WOOD TRUSSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop-fabricated wood trusses.
- B. Truss bridging.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ANSI/TPI 1 - National Design Standard for Metal-Plate-Connected Wood Truss Construction; 2014.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- D. ASTM F1667/F1667M - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples; 2021a.
- E. PS 20 - American Softwood Lumber Standard; 2021.
- F. SBCA (BCSI) - Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses; 2018 (Updated 2020).
- G. TPI DSB-89 - Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses; 1989.

1.04 DEFINITIONS

- A. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.05 ACTION SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets for plate connectors, bearing plates, and metal bracing components.
- C. Shop Drawings: Show fabrication and installation details for trusses.
 - 1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
 - 2. Indicate sizes, stress grades, and species of lumber.
 - 3. Indicate locations, sizes, and materials for permanent bracing required to prevent buckling of individual truss members due to design loads.
 - 4. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
 - 5. Show splice details and bearing details.
- D. Delegated-Design Submittal: For metal-plate-connected wood trusses 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 identification of engineering software used for design.

2. Provide shop drawings stamped or sealed by design engineer.
3. Submit design calculations.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Material Certificates: For dimension lumber specified to comply with minimum specific gravity. Indicate species and grade selected for each use and specific gravity.
- C. Product Certificates: For metal-plate-connected wood trusses, signed by officer of truss-fabricating firm.
- D. Evaluation Reports: For the following, from ICC-ES:
 1. Metal-plate connectors.
 2. Metal truss accessories.

1.07 QUALITY ASSURANCE

- A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in ANSI/TPI 1 for manufacture of connector plates.
 1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
 2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
- B. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Handle trusses in accordance with SBCA (BCSI).
 1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
 2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
 3. Provide for air circulation around stacks and under coverings.
- B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

PART 2 PRODUCTS

2.01 TRUSSES

- A. Wood Trusses: Design and fabricate trusses in accordance with ANSI/TPI 1, SBCA (BCSI) , TPI DSB-89 and to achieve specified design requirements indicated.
 1. Design and fabricate temporary bracing in accordance with TPI DSB-89.
 2. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."
 3. Design Loads: As indicated.
 4. Roof Deflection: 1/240 of span, or 1" maximum.

2.02 MATERIALS

- A. Lumber: DOC PS 20 and applicable rules of any rules-writing agency certified by the American Lumber Standard Committee (ALSC) Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Provide dressed lumber, S4S.
 - 4. Provide dry lumber with 15 percent maximum moisture content at time of dressing.
- B. Truss Bridging: Type, size and spacing recommended by truss manufacturer.

2.03 METAL CONNECTOR PLATES

- A. General: Fabricate connector plates to comply with ANSI/TPI 1.
- B. Hot-Dip Galvanized-Steel Sheet: ASTM A653/A653M ; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 (Z180) coating designation; and not less than 0.036 inch thick.
 - 1. Use for interior locations unless otherwise indicated.

2.04 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.
- B. Nails, Brads, and Staples: ASTM F1667/F1667M.

2.05 METAL FRAMING ANCHORS AND ACCESSORIES

- A. Allowable design loads, as published by manufacturer, shall comply with or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.
- B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 (Z180) coating designation.
 - 1. Use for interior locations unless otherwise indicated.
- C. Hot-Dip Heavy-Galvanized-Steel Sheet: ASTM A653/A653M ; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch thick.
 - 1. Use for wood-preservative-treated lumber and where indicated.
- D. Stainless-Steel Sheet: ASTM A666, Type 316.
 - 1. Use for exterior locations and where indicated.
- E. Truss Tie-Downs: As indicated.

2.06 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20, with dry film containing a minimum of 92 percent zinc dust by weight.

2.07 FABRICATION

- A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
- B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.
- C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly, with joints closely fitted to comply with tolerances in ANSI/TPI 1. Position members to produce design camber indicated.
 - 1. Fabricate wood trusses within manufacturing tolerances in ANSI/TPI 1 .
- D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

PART 3 EXECUTION

3.01 ERECTION

- A. Install trusses in accordance with manufacturer's instructions, SBCA (BCSI); maintain a copy of applicable documents on site until installation is complete.
- B. Set members level and plumb, in correct position.
- C. Make provisions for erection loads, and for sufficient temporary bracing to maintain structure plumb, and in true alignment until completion of erection and installation of permanent bracing.
- D. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchors according to manufacturer's fastening schedules and written instructions.
- E. Do not field-cut or alter structural members without approval of Architect.
- F. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
- G. Securely connect each truss ply required for forming built-up girder trusses.
 - 1. Anchor trusses to girder trusses as indicated.
- H. Replace wood trusses that are damaged or do not comply with requirements.
 - 1. Damaged trusses may be repaired according to truss repair details signed and sealed by the qualified professional engineer responsible for truss design, when approved by Architect.

3.02 REPAIRS AND PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

3.03 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections to verify that temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

END OF SECTION

**SECTION 06 2000
FINISH CARPENTRY**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior finish carpentry items, including:
 - 1. Wood casings and trim.
 - 2. Fixed closet and storage shelving.
 - 3. Other items as specified in this Section and as indicated on Drawings.

1.02 REFERENCE STANDARDS

- A. ANSI A208.2 - American National Standard for Medium Density Fiberboard for Interior Use.
- B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards.

1.03 SUBMITTALS

- A. See Section 01 3000 - 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. Samples: Submit two samples of each type of wood trim, 12 inch long, illustrating profiles and completed finishes.

1.04 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this Section with minimum five years of documented experience.
 - 1. Single Source Responsibility: Provide and install this work from single fabricator.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store finish carpentry items under cover, elevated above grade, and in a dry, well-ventilated area not exposed to heat or sunlight.
 - 1. Store finish carpentry items in installation areas. If finish carpentry items must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.
 - 2. Stack lumber and provide for adequate air circulation within and around stacks and under temporary coverings.
 - 3. Protect from moisture damage.
- B. Handle materials and products to prevent damage to edges, ends, or surfaces.

1.06 ENVIRONMENTAL CONDITIONS

- A. Comply with specified standard and as additionally specified.

- B. Do not deliver finish carpentry items until environmental conditions meet specified requirements for installation areas.
- C. Do not deliver or install finish carpentry items until building is enclosed and weatherproof, wet work in installation areas is complete and nominally dry, and building's environmental control systems are operating and will maintain temperature and relative humidity at designed occupancy levels throughout the remainder of the construction period.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS

- A. Quality Standard - General: Custom Grade, in accordance with AWI/AWMAC/WI (AWS), unless otherwise specified for each carpentry item.
- B. Interior Woodwork Items:
 - 1. Casings, Sills, and Miscellaneous Trim: Medium density fiberboard; prepare for paint finish.
 - 2. Closet Shelving: Medium density fiberboard; prepare for paint finish.

2.02 SHEET MATERIALS

- A. Medium Density Fiberboard (MDF): ANSI A208.2; pressed hardwood fibers, made with waterproof resin binders, tempered grade; sanded faces.

2.03 FASTENINGS

- A. Fasteners: Of size and type to suit application; galvanized finish.
- B. Concealed Joint Fasteners: Threaded steel.

2.04 ACCESSORIES

- A. Lumber for Shimming and Blocking: Softwood lumber of fir or pine species.
- B. Closet Rods: Formed aluminum sheet with mounting plates on both ends; 1-1/4 inch diameter; lengths as indicated on Drawings.
 - 1. Mounting Brackets: Formed steel brackets designed to support wood shelf and continuous hanging rod; vertical leg with holes top and bottom for mall-mounting using lag screws into wall studs or solid blocking.
- C. Primer: Alkyd primer sealer.
- D. Wood Filler: Latex base, tinted to match surface finish color.

2.05 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.
- C. Apply specified laminate to shelving on all exposed surfaces and edges.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify mechanical, electrical, and building items affecting work of this Section are placed and ready to receive this work.

3.02 INSTALLATION

- A. Install custom fabrications in accordance with AWI/AWMAC/WI (AWS) requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.
- D. Install components with finish nails at maximum 8 inch on center.
- E. Install finish carpentry items with minimum number of joints practical, using full length pieces from maximum lengths of lumber available. Do not use individual pieces less than 24 inches long, except where necessary.
 - 1. Cope at returns and miter at corners to produce tight-fitting joints with full surface contact throughout the length of joints.
 - 2. Plane back surfaces of casings as required to provide uniform thickness and flush finished surfaces across joints.
- F. Install trim after finishing of substrate surfaces is complete.
- G. Pre-drill pilot holes in hardwood carpentry items before fastening to prevent splitting. Securely fasten to prevent warping or movement.

3.03 PREPARATION FOR SITE FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
- B. Site Finishing: See Section 09 9123.

3.04 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch.
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

3.05 PROTECTION

- A. Protect installed finish carpentry items from damage due to subsequent construction operations.

END OF SECTION

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SECTION 06 4100
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specially fabricated cabinet and casework units, including:
 - 1. Hardware.
- B. Preparation for installing utilities.

1.02 RELATED REQUIREMENTS

- A. Section 12 3600 - Countertops.

1.03 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards.
- B. BHMA A156.9 - American National Standard for Cabinet Hardware.
- C. NEMA LD 3 - High-Pressure Decorative Laminates.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Field verify critical dimensions and clearances prior to fabrication of casework items; assure that field conditions are as required to comply with indicated design requirements.
 - 2. Verify accurate field measurements in installation areas before wall cavities are enclosed; verify locations of concealed framing, blocking, reinforcements, and furring that support woodwork; record measurements on shop drawings.
 - 3. Where field measurements cannot be made without delaying work, establish required dimensions and maintain those dimensions for fabrication of woodwork.
 - 4. Coordinate construction to ensure that actual dimensions correspond to established required dimensions.
 - 5. Coordinate cabinet spacing and clearances to ensure that doors and drawers do not conflict with each other.
 - 6. Coordinate cabinet opening and spacing requirements with approved appliances and plumbing fixtures.

1.05 SUBMITTALS

- A. See Section 01 3000 - 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 information as required by AWI/AWMAC/WI (AWS).
 - 3. Shop drawings are required to be generated as separate digital drawings specific to this Project, not utilizing Architect's digital drawing files in any manner; comply with other restrictions on use of Architect's digital drawing files specified in Section 01 3000.

4. Show all adjacent construction including abutting walls, columns and similar elements affecting casework installation.

C. Product Data: Provide data for hardware accessories.

D. Samples: Submit actual samples of architectural cabinet face construction, minimum 12 inches square, illustrating proposed cabinet substrate and finish.

1.06 QUALITY ASSURANCE

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

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

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver casework items to installation areas only after clean, well ventilated, and temperature-controlled installation areas are available. Do not deliver casework items to installation areas until painting and similar operations are complete in those areas.

B. Protect units from moisture and impact damage during transit, delivery, and storage; use protective covers during delivery, storage, and handling operations.

1.08 FIELD CONDITIONS

A. Do not deliver or install casework items until building is enclosed and weatherproof, and building's environmental control systems are operating and will maintain temperature and relative humidity at designed occupancy levels throughout the remainder of the construction period.

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

PART 2 PRODUCTS

2.01 WOOD CASEWORK AND CABINETS

A. Quality Standard - General: Grades as indicated or specified, in accordance with AWI/AWMAC/WI (AWS).

1. Plastic Laminate Faced Cabinets:

a. Quality Standard: Custom Grade, unless noted otherwise.

b. Structural Performance Duty Level: 2 (Commercial).

2.02 LAMINATE MATERIALS

A. High Pressure Decorative Laminate (HPDL): NEMA LD 3; colors as indicated or specified on Drawings.

1. Provide specific types as follows:

a. Horizontal Surfaces: HGS, 0.048 inch nominal thickness.

b. Vertical Surfaces: VGS, 0.028 inch nominal thickness.

c. Cabinet Liner: CLS, 0.020 inch nominal thickness.

d. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.03 COUNTERTOPS

A. Countertops: See Section 12 3600.

2.04 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.

2.05 HARDWARE

- A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified, unless otherwise specified in this Section.
 - 1. Finishes: Selected from manufacturer's standard line for each type of hardware
- 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: "U" shaped wire pull, steel with satin finish, 4 inch centers.
- D. Cabinet Locks: Keyed cabinet-grade lock, two keys per lock, steel with satin finish.
- E. Drawer Slides:
 - 1. Type: Full extension with overtravel.
 - 2. Static Load Capacity: Commercial grade.
 - 3. Mounting: Side mounted.
 - 4. Stops: Integral type.
 - 5. Features: Provide self-closing/stay-closed/soft-close type.
- F. Hinges: European style concealed, self-closing type, steel with satin finish.
 - 1. Features: Provide self-closing/stay-closed/soft-close type.
- G. Door Bumpers: Drilled-in, clear, soft plastic.

2.06 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. Locate counter butt joints minimum 2 feet from sink cut-outs.
 - 1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
 - 2. Apply thermally fused laminate to inside of cabinets on exposed and semi-exposed surfaces, and to shelving surfaces.

- E. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify location and sizes of utility rough-in associated with work of this Section.
- C. Verify critical clearances and dimensions prior to installation of casework items.

3.02 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.
- G. Secure full height cabinets, shelving units, and similar casework items exceeding 60 inches in height to floor using appropriate angles and anchorages.
- H. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 ADJUSTING

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

3.04 CLEANING

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

3.05 PROTECTION

- A. Protect installed casework items from damage due to subsequent construction operations.

END OF SECTION

SECTION 06 8316
FIBERGLASS REINFORCED PLASTIC (FRP) PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fiberglass reinforced plastic panels.
- B. Accessories and trim.

1.02 REFERENCE STANDARDS

- A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- B. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- C. ASTM D5319 - Standard Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ISO 846 - Plastics - Evaluation of the action of microorganisms.
- F. ISO 2812-1 - Paints and varnishes -- Determination of resistance to liquids -- Part 1: Immersion in liquids other than water.

1.03 SUBMITTALS

- A. See Section 01 3000 - 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.

1.04 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.

1.05 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers - Panels:
 - 1. Crane Composites, Inc.: www.cranecomposites.com.
 - 2. Kemlite: www.kemlite.com.
 - 3. Marlite, Inc.: www.marlite.com/#sle.
 - 4. Nudo Products, Inc.: www.nudo.com/#sle.
 - 5. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PANEL SYSTEMS

A. Wall Panels:

1. Panel Size: As indicated on Drawings.
2. Panel Thickness: 0.10 inch (2.5 mm).
3. Surface Design: Smooth.
4. Color: As selected by Architect from manufacturer's full line.
5. Attachment Method: Adhesive only, with trim and sealant in joints.

2.03 MATERIALS

A. Panels: Fiberglass reinforced plastic (FRP), complying with ASTM D5319.

1. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when system tested in accordance with ASTM E84.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Impact Strength: Greater than 6 ft lb force per inch, when tested in accordance with ASTM D256.
4. Chemical Cleanability: Excellent chemical resistance to common cleaners and detergents when tested in accordance with ISO 2812-1.
5. Biological Resistance: Rating of 0, when tested in accordance with ISO 846.

B. Trim: Vinyl; color coordinating with panel.

C. Adhesive: Type recommended by panel manufacturer.

D. Sealant: Silicone; color matching panel.

PART 3 EXECUTION

3.01 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.

3.02 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

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**SECTION 07 1913
WATER REPELLENT COATINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water repellents applied to exterior concrete masonry veneer surfaces.

1.02 REFERENCE STANDARDS

- A. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a meeting at least one week prior to starting work; require attendance of affected installers; invite Architect and Owner.
 - 1. Convene under general provisions of Section 01 7000.
 - 2. Discuss manufacturer's application requirements and limitations.

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience

1.06 MOCK-UPS

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Mock-up: Prepare a representative surface 36 by 36 inch in size using specified materials and preparation and application methods on surfaces identical to those to be coated; approved mock-up constitutes standard for workmanship.
 - 1. For proposed substitutions, prepare side-by-side mock-ups of specified and substitute products.
 - 2. Locate where directed.
 - 3. Mock-up may remain as part of work.

1.07 FIELD CONDITIONS

- A. Protect liquid materials from freezing.

- B. Do not apply coating when ambient temperature is lower than 50 degrees F or higher than 100 degrees F.
- C. Do not apply coatings, except with the written recommendation of the manufacturer, when the substrate surfaces have cured for less than a period of 60 days; when rain or temperatures below 50 degrees F are predicted for a period of 24 hours; earlier than 3 days after the surfaces became wet from rainfall or other moisture sources; when the substrate is frozen; or on substrate temperature of less than 40 degrees F.
- D. Do not apply coatings when wind velocity is higher than 20 mph.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide five year manufacturer warranty for water repellents.
 - 1. Include coverage for degradation of waterproofing ability on designated substrate.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Coatings: Non-glossy, colorless, penetrating, water-vapor-permeable, non-yellowing sealer, that dries invisibly leaving appearance of substrate unchanged.
 - 1. Minimum Number of Coats: Two.
 - 2. Moisture Absorption When Applied to Masonry: Five percent, maximum, when tested in accordance with ASTM C140/C140M using masonry sample completely coated with water repellent.
 - 3. Maintains dry appearance when wetted.
- B. Water Repellent: Water-based siloxane, silane, or blend that reacts chemically with concrete and masonry.
 - 1. Acceptable Products:
 - a. Nox-Crete Inc; Stifel Series Products: www.nox-crete.com/#sle.
 - b. PPG Paints Perma-Crete Aqua-Pel Clear Water Repellent, 4-6100. (MPI #34): www.ppgpaints.com/#sle.
 - c. PROSOCO, Inc.; Sure Klean Weather Seal H40: www.prosoco.com/#sle.
 - d. Sherwin-Williams Company; Loxon 7 Percent Siloxane, with VOC of Zero g/L: www.sherwin-williams.com/#sle.
 - e. United Gilsonite Laboratories; DRYLOK Siloxane 7 Brick and Masonry Penetrating Sealer: www.ugl.com/#sle.
 - f. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 APPLICATION

- A. Apply in accordance with coating manufacturer's instructions, using procedures and application methods recommended as producing the best results.
- B. Apply at rate recommended by coating manufacturer, continuously over entire surface.
- C. Comply with coating manufacturer's instructions for limitations on drying time between coats, and for drying times after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if recommendations are not applicable to project conditions.
- D. Delay application of coating until installation of sealants has been completed in joints adjoining surfaces to be coated.
- E. Remove coating from unintended surfaces immediately by a method instructed by coating manufacturer.
- F. Provide manufacturer's field service representative to inspect preparation and application work continuously during entire application period to ensure that manufacturer's "best practices" for preparation and application are being followed.

END OF SECTION

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**SECTION 07 2100
THERMAL INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Thermal foam board insulation:
 - 1. Perimeter of foundation.
 - 2. Insulation over metal stud framed walls with wood sheathing - continuous insulation.
- B. Thermal batt insulation in exterior envelope applications, unless specified as part of an assembly in other Section(s):
 - 1. Insulation in metal framed walls.
 - 2. Insulation in wood framed roof/ceiling (attic) structure.
- C. Separate and associated vapor retarders not specified in other Sections.

1.02 DEFINITIONS

- A. Mineral Fiber Material Composition: Insulation referred to as mineral fiber block, board, and blanket insulation is composed of fibers from mineral based substances such as rock, slag, or glass and processed from the molten state into fibrous form.
 - 1. Based on type of insulation substance, the material will be referred to as a mineral fiber when having a rock or slag base, and glass fiber with a glass or silica sand base, also considered a mineral.
 - 2. Insulation blankets are flexible units consisting of felted, bonded, or unbonded fibers formed into rolls or flat cut pieces referred to as batts; rolls are simply longer versions of batts.
 - 3. For additional information about mineral fiber and the various classification types, refer to the following reference standards; ASTM C553, ASTM C612, ASTM C665, and ASTM C726.

1.03 REFERENCE STANDARDS

- A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- B. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- E. ASTM C726 - Standard Specification for Mineral Wool Roof Insulation Board.
- F. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- I. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C.
- J. ASTM E2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Do not allow insulation materials to become wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage, and protection during installation.
- B. Protect plastic insulation from exposure to direct sunlight.
- C. Do not deliver plastic insulation materials to the project site ahead of time of installation. Protect at all times against ignition. Complete the installation and concealment of plastic materials as soon as possible in each area of work.

1.06 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. As specified in this Section for each insulation type and application.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 APPLICATIONS

- A. Insulation at Perimeter of Foundation: Extruded polystyrene (XPS) board.
- B. Insulation Over Metal Stud Framed Walls - Continuous: Polyisocyanurate board.
- C. Insulation in Metal Framed Walls: Batt insulation with separate vapor retarder.
- D. Insulation in Wood Framed Roof/Ceiling (Attic) Structure: Batt insulation with separate vapor retarder.

2.03 INSULATION MATERIALS - GENERAL

- A. Where units are included in fire rated wall, ceiling, or floor construction, provide insulation units which have been tested and rated as required for the indicated assembly.

2.04 FOAM BOARD INSULATION MATERIALS

- A. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578 with either natural skin or cut cell surfaces.
 - 1. Type and Compressive Resistance: Type IV, 25 psi (173 kPa), minimum.
 - 2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
 - 3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.

4. Type and Thermal Resistance, R-value: Type IV, 5.0 (0.88), minimum, per 1 inch thickness at 75 degrees F mean temperature.
5. Board Thickness: As indicated on Drawings.
6. Board Edges: Square.
7. Type and Water Absorption: Type XII, 0.3 percent by volume, maximum, by total immersion.
8. Acceptable Products:
 - a. DuPont de Nemours, Inc.; Styrofoam Brand Square Edge: building.dupont.com/#sle.
 - b. Kingspan Insulation LLC; GreenGuard GG25-LG XPS Insulation Board: www.kingspan.com/#sle.
 - c. Owens Corning Corporation; FOAMULAR Type IV Extruded Polystyrene (XPS) Insulation: www.ocbuildingspec.com/#sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

B. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, comply with ASTM C1289.

1. Classification: Type II; faced with either cellulosic facers or glass fiber mat facers on both major surfaces of the core foam.
 - a. Class 1 - Faced with glass fiber reinforced cellulosic facers on both major surfaces of core foam.
 - b. Compressive Strength: Classes 1-2-3, Grade 1 - 16 psi (110 kPa), minimum.
 - c. Thermal Resistance, R-value: At 1-1/2 inch thick; Class 1, Grades 1-2-3 - 8.4 (1.48), minimum, at 75 degrees F.
2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
4. Board Size: 48 inch by 96 inch.
5. Board Thickness: 2.0 inch, unless otherwise indicated on Drawings.
6. Board Edges: Square.
7. Acceptable Products:
 - a. Carlisle Coatings & Waterproofing, Inc.; R2+ Matte: www.carlisleccw.com/#sle.
 - b. DuPont de Nemours, Inc.; Thermax (ci): building.dupont.com/#sle.
 - c. GAF; EnergyGuard Polyiso Insulation: www.gaf.com/#sle.
 - d. Johns Manville; CI Max: www.jm.com/#sle.
 - e. Substitutions: See Section 01 6000 - Product Requirements.

2.05 MINERAL FIBER BLANKET (BATT) INSULATION MATERIALS

- A. Flexible Glass Fiber Blanket Thermal Insulation: Preformed insulation, complying with ASTM C665; friction fit.
1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 2. Smoke Developed Index: 50 or less, when tested in accordance with ASTM E84.
 3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
 4. Thermal Resistance: As noted on Drawings, minimum value.
 5. Thickness: Full thickness of framing or cavity space indicated, unless otherwise specifically noted on Drawings.
 6. Facing: Provide un-faced.
 7. Acceptable Manufacturers:
 - a. CertainTeed Corporation: www.certainteed.com.
 - b. Johns Manville: www.jm.com.

- c. Knauf Insulation: www.knaufinsulation.us.
- d. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- e. Substitutions: See Section 01 6000 - Product Requirements.

2.06 ACCESSORIES

- A. Vapor Retarder Sheet: Polyamide nylon sheet, clear color.
 - 1. Thickness: 2 mil, 0.02 inch.
 - 2. Water Vapor Permeance: 1.0 perm, maximum, when tested in accordance with ASTM E96/E96M, Dessicant Method.
 - a. Maximum 1.0 is required to comply with applicable code for attic ventilation requirement.
 - 3. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less (Class A), when tested in accordance with ASTM E84.
 - 4. Seam Lap and Perimeter Adhesive: Elastomeric, same composition as sheet or other compatible material required by sheet manufacturer.
 - 5. Acceptable Product:
 - a. Certainteed Corporation; MemBrain Continuous Air Barrier & Smart Vapor Retarder: www.certainteed.com
 - b. Substitutions: See Section 01 6000 - Product Requirements.
- B. Foam Board Insulation Fasteners: Insulation manufacturer's recommended polymer or other corrosion-resistant coated steel screws, with compatible 2 inch diameter plastic washers, designed for anchoring sheathing to metal stud framing and other indicated backing materials; fastener length as required for thickness of insulation material and penetration of structural backing framing or substrates as indicated.
- C. Wire Mesh: Galvanized steel, hexagonal wire mesh.
- D. Protection Board for Below Grade Insulation: Cementitious, 1/4 inch thick.
- E. Adhesive: Type recommended by insulation manufacturer for indicated applications.
- F. Penetration and Gap Filler: Foamed-in-place insulation; type as specified in Section 07 2119.

PART 3 EXECUTION

3.01 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.

3.02 BOARD INSTALLATION AT FOUNDATION PERIMETER

- A. Apply specified adhesive to back of boards.
 - 1. Three continuous beads per board length.
- B. Install boards horizontally on foundation perimeter.
 - 1. Place boards to maximize adhesive contact.
 - 2. Install in running bond pattern.
 - 3. Butt edges and ends tightly to adjacent boards and to protrusions.

- C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
- D. Immediately following application of board insulation, place protective boards over exposed insulation surfaces.
 - 1. Apply specified adhesive in five continuous beads per board length.
 - 2. Install boards horizontally from base of foundation to top of insulation.
 - 3. Butt boards tightly, with joints staggered from insulation joints.

3.03 BOARD INSTALLATION AT EXTERIOR WALLS

- A. Install rigid insulation directly to exterior grade sheathing with specified fasteners at maximum 16 inches on center with manufacturer's recommended mechanical fasteners.
 - 1. Tape joints in insulation using manufacturer's required flashing tape product, in accordance with insulation manufacturer's instructions for joint types indicated or required.
 - 2. Seal joints in insulation with specified penetration and gap filler in accordance with manufacturer's instructions for joint types indicated or required.
- B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.04 BATT INSULATION INSTALLATION

- A. Installation - General:
 - 1. Install insulation and vapor retarder at locations indicated and in accordance with manufacturer's instructions.
 - 2. Install in exterior wall and attic spaces without gaps or voids. Do not compress insulation.
 - 3. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
 - 4. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
 - 5. Separate Vapor Retarder Membranes: Install at location within assembly where indicated on Drawings. Extend tightly to full perimeter of adjacent window, door, and other opening frames, and other items interrupting plane of vapor membrane. Tape seal in place.
- B. Roof/Ceiling (Attic) Assemblies: Retain insulation batts in place with wire mesh secured to framing members in accordance with tested assembly requirements.
- C. Tape seal butt ends, lapped flanges, and tears or cuts in vapor retarder membranes.

3.05 PROTECTION

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

END OF SECTION

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**SECTION 07 2119
FOAMED-IN-PLACE INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Foamed-in-place insulation:
 - 1. In exterior wall crevices.
 - 2. In shim spaces at windows, storefront frames, and similar locations.
 - 3. At junctions of dissimilar wall and roof materials.

1.02 REFERENCE STANDARDS

- A. AAMA 812 - Voluntary Practice for Assessment of Single Component Aerosol Expanding Polyurethane Foams for Sealing Rough Openings of Fenestration Installations.
- B. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.
- C. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- F. ASTM E2178 - Standard Test Method for Air Permeance of Building Materials.
- G. FM 4880 - Approval Standard for Class 1 Fire Rating of Building Panels or Interior Finish Materials.
- H. NFPA 275 - Standard Method of Fire Tests for the Evaluation of Thermal Barriers.
- I. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.
- J. UL 1040 - Standard for Safety Fire Test of Insulated Wall Construction.
- K. UL 1715 - Standard for Safety Fire Test of Interior Finish Material.
- L. NFPA 275 - Standard Method of Fire Tests for the Evaluation of Thermal Barriers.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.
- C. Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer certification on site during and after installation. Present on-site documentation upon request.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience.

1.05 FIELD CONDITIONS

- A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.
- B. Do not apply foam when temperature is within 5 degrees F of dew point.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Foamed-In-Place Insulation: Medium-density, rigid or semi-rigid, closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
 - 1. Applications: All applications unless otherwise specified.
 - 2. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment, and fire protection requirements.
 - a. Fire Protection: Provide 15-minute thermal barrier of 1/2 inch gypsum board or equivalent material complying with NFPA 275 test method, or foamed-in-place insulation either exposed or with covering that complies with FM 4880, NFPA 286, UL 1040, or UL 1715.
 - b. Comply with testing requirements according to NFPA 275.
 - 3. Density In Place: Minimum 2.0 lb/cu ft.; ASTM D1622.
 - 4. Thermal Resistance: R-value of 5.0, minimum, per 1 inch thickness at 75 degrees F mean temperature when tested in accordance with ASTM C518.
 - 5. Water Vapor Permeance: Vapor retarder; 2 perms, maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.
 - 6. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
 - 7. Air Permeance: 0.04 cfm per square foot, maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf.
 - 8. Closed Cell Content: At least 90 percent.
 - 9. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
 - 10. Acceptable Products:
 - a. BASF Corporation; SPRAYTITE 158: www.spf.basf.com/#sle.
 - b. Carlisle Spray Foam Insulation; SealTite Pro Closed Cell: www.carlisesfi.com/#sle.
 - c. Gaco Western; GacoOnePass F1850R: www.gaco.com/#sle.
 - d. Huntsman Building Solutions; ProSeal HFO: www.huntsmanbuildingsolutions.com/#sle.
 - e. Johns Manville; JM Corbond III Closed Cell Spray Polyurethane Foam: www.jm.com/#sle.
 - f. Preferred Solutions, Inc.; Staycell 504 Closed Cell Spray Foam Insulation: www.preferredsolutions.net/#sle.
 - g. Rhino Linings Corporation; DuraTite CC2.5: www.rhino linings.com/#sle.
 - h. Substitutions: See Section 01 6000 - Product Requirements.
- B. Foamed-in-Place Insulation/Sealant: Low density, multi-component, quick cure polyurethane foam, chemically cured, low-pressure spray foam.
 - 1. Applications: Shim spaces around opening frames.
 - 2. Density In Place: 1.0 lb/cu ft.; ASTM D1622.
 - 3. Complies with AAMA 812.

4. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
5. Acceptable Products:
 - a. DuPont de Nemours, Inc.; GREAT STUFF PRO Gaps and Cracks single component polyurethane low-pressure sealant: www.building.dupont.com/#sle.
 - b. Hilti USA; CF 812 Window & Door Pro Low Pressure Filler Foam: www.hilti.com/#sle.
 - c. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ACCESSORIES

- A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify work within construction spaces or crevices is complete before insulation application.
- B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

3.02 PREPARATION

- A. Mask and protect adjacent surfaces from over spray or dusting.
- B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION

- A. Apply insulation in accordance with manufacturer's instructions.
- B. Apply insulation by spray method, to a uniform monolithic density without voids. Screed away excess foam to produce smooth and uniformly textured exposed surfaces.
- C. Patch damaged areas.
- D. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts or void applicable warranties of windows and other opening components.

3.04 PROTECTION

- A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION

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SECTION 07 2700
AIR BARRIERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air barriers.
- B. Air barrier system accessories, including:
 - 1. Sealants, tapes, and accessories for sealing air barrier and adjacent substrates.
 - 2. Other specified system accessories.

1.02 DEFINITIONS

- A. Air Barrier: Airtight barrier made of material that is virtually air impermeable but may be water vapor permeable, both to amount as specified, with sealed seams and sealed joints to adjacent surfaces.

1.03 REFERENCE STANDARDS

- A. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
- B. ASTM E2112 - Standard Practice for Installation of Exterior Windows, Doors and Skylights.
- C. ASTM E1677 - Standard Specification for an Air Barrier (AB) Material or System for Low-Rise Framed Building Walls.
- D. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- E. ASTM E2178 - Standard Test Method for Air Permeance of Building Materials.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of weather barriers with adjacent flashings and weather barriers for compatibility and continuity of those systems.
 - 2. Coordinate installation of flexible flashing at openings with Sections that specify window, door, and other opening installations.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this Section; require attendance by all affected installers.
 - 1. Convene under general provisions of Section 01 7000.
 - 2. Discuss installation procedures, requirements for items that penetrate the system, and other pertinent issues.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on material characteristics, performance criteria, and limitations.
- C. Shop Drawings: Provide drawings of special joint conditions, including special flashing conditions where incompatible materials are in close proximity to or in contact with specified air barriers.

- D. Manufacturer's Installation Instructions: Indicate preparation, installation methods, and storage and handling criteria.
- 1.06 QUALITY ASSURANCE
- A. Installer Qualifications: Company specializing in performing the work of this Section with minimum three years documented experience.
 - B. System Compatibility: Assume responsibility for confirming that weather barrier system components are compatible with each other as a system, and also compatible with substrate surfaces with which they will be in contact, including but not limited to wall and sheathing surfaces, opening materials, other flashings and weather barrier materials, and joint sealants.
 - 1. Assure that system components are compatible as specified prior to preparing and making specified submittals.
 - 2. Assume responsibility for removal of incompatible system components and installation of properly compatible components at no additional cost to Owner regardless of when incompatibility is discovered.
- 1.07 FIELD CONDITIONS
- A. Maintain temperature and humidity recommended by materials manufacturers before, during, and after installation.

PART 2 PRODUCTS

2.01 AIR BARRIER ASSEMBLIES

- A. Air Barriers:
 - 1. On outside of exterior continuous insulation use air barrier coating.

2.02 AIR BARRIER MATERIALS (AIR IMPERMEABLE AND WATER VAPOR PERMEABLE)

- A. Air Barrier Coating:
 - 1. Dry Film Thickness (DFT): 20 mil, 0.020 inch, minimum.
 - 2. Air Permeance: 0.004 cfm/sq ft, maximum, when tested in accordance with ASTM E2178.
 - 3. Water Vapor Permeance: 11 perms, minimum, when tested in accordance with ASTM E96/E96M using Procedure B - Water Method, at 73.4 degrees F.
 - 4. Ultraviolet (UV) and Weathering Resistance: Approved by manufacturer for up to 90 days of weather exposure.
 - 5. Nail Sealability: Pass, when tested in accordance with ASTM D1970/D1970M.
 - 6. Sealants, Tapes and Accessories: As recommended by coating manufacturer.
 - 7. Acceptable Products:
 - a. Dow Chemical Company; DOWSIL DefendAir 200C: consumer.dow.com/en-us/industry/ind-building-construction.html/#sle.
 - b. DuPont de Nemours, Inc.; Tyvek Fluid Applied WB+ with Tyvek Fluid Applied Flashing and Joint Compound, Sealant for Tyvek Fluid Applied System, and StraightFlash: building.dupont.com/#sle.
 - c. GCP Applied Technologies; Perm-A-Barrier VPL 50RS UV Stable: www.gcpat.com/#sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.03 ACCESSORIES

- A. Sealants, Tapes, and Accessories for Sealing Air Barrier and Adjacent Substrates: As indicated or in compliance with air barrier manufacturer's installation instructions.
- B. Accessory Components: As recommended by primary weather barrier membrane manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and conditions are ready for work of this Section.
- B. Where existing conditions are responsibility of another installer, notify Architect of unsatisfactory conditions.
- C. Do not proceed with this work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.
- B. Clean and prime substrate surfaces to receive adhesives and sealants in accordance with manufacturer's installation instructions.

3.03 INSTALLATION

- A. Install materials in accordance with basis of design manufacturer's instructions and ASTM E1677, and as otherwise specified in this Section.
 - 1. Also comply with applicable requirements of ASTM E2112 for installation of air barrier materials in conjunction with installation of windows, aluminum storefronts, doors, and louvers.
- B. Apply sealants and adhesives within recommended temperature range in accordance with manufacturer's installation instructions.
- C. 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. Cold Weather Applications: Comply with manufacturer's protocols and special application instructions.
 - 3. Where exterior masonry veneer is being installed, install masonry anchors before installing air barrier over masonry; provide airtight seal around anchors.
 - 4. Apply bead or trowel coat of mastic sealant with minimum thickness of 1/4 inch along coating seams, rough cuts, and as recommended by manufacturer.
 - 5. Use flashing to seal to adjacent construction and to bridge joints in coating substrate.
 - 6. Provide flexible flashing or extra thickness of reinforced coating at all changes in plane, intersections with other weather barriers, flashings, and other components of the weather barrier enclosure.
- D. 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.
7. Masonry Veneer Wall Ties: Seal penetrations through weather barrier membrane with manufacturer's recommended sealant or sealing system.

3.04 FIELD QUALITY CONTROL

- A. Do not cover installed air barriers until required inspections have been completed.
- B. Obtain approval of installation procedures from air barrier manufacturer based on a mock-up installed in place, prior to proceeding with remainder of installation.
- C. Take digital photographs of each portion of installation prior to covering up air barriers.

3.05 PROTECTION

- A. Protect installed air barrier systems and associated flashings from damage until covered by subsequent construction.
- B. Do not leave materials exposed to weather longer than recommended by manufacturer.

END OF SECTION

**SECTION 07 3113
ASPHALT SHINGLES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Asphalt shingle roofing, including:
 - 1. Flexible sheet membranes for underlayment and valley protection.
 - 2. Flashings.
- B. Accessories, including:
 - 1. Ridge venting accessories.

1.02 REFERENCE STANDARDS

- A. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
- B. ASTM D3161/D3161M - Standard Test Method for Wind-Resistance of Steep Slope Roofing Products (Fan-Induced Method).
- C. ASTM D3462/D3462M - Standard Specification for Asphalt Shingles Made From Glass Felt and Surfaced with Mineral Granules.
- D. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings.
- E. ASTM F1667/F1667M - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- F. NRCA (RM) - The NRCA Roofing Manual.
- G. SMACNA (ASMM) - Architectural Sheet Metal Manual.
- H. UL (DIR) - Online Certifications Directory.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate installation of roof mounted components or work projecting through roof with weather tight placement of counterflashings.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating material characteristics, performance criteria, and limitations.
- C. Samples: Submit two samples of each shingle color indicating color range and finish texture/pattern; for color selection.
- D. Manufacturer's Installation Instructions: Indicate installation criteria and procedures.
- E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing asphalt shingles, with at least 3 years of documented experience.

1.06 MOCK-UPS

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Mock-Up: Provide a mock-up for evaluation of shingle installation workmanship, including typical eave, rake, valley, and ridge details.
 - 1. Provide mock-up of 100 sq ft, including underlayment, shingles, and associated flashings.
 - 2. Locate as directed by Architect.
 - 3. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store materials with labels intact in manufacturer's unopened packaging until ready for installation.
- B. Store materials under dry and waterproof cover, well ventilated, and elevated above grade on a flat surface.
- C. Protect materials from harmful environmental elements, construction dust, direct sunlight, and other potentially detrimental conditions.
- D. When storing roofing materials on roofing system ensure that no damage occurs to supporting members and other materials.

1.08 FIELD CONDITIONS

- A. Do not install shingles, eave protection membrane or underlayment when surface, ambient air, or wind chill temperatures are below 45 degrees F.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer's Warranty: Provide 40 year manufacturer's warranty coverage for product degradation, and coverage against black streaks and other visible defects caused by algae.
 - 1. Provide 10 -year manufacturer's warranty for wind damage.
- C. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Atlas Roofing Corporation: www.atlasroofing.com/#sle.
 - 2. Elk Premium Building Products, Inc.: www.elkcorp.com.
 - 3. GAF: www.gaf.com/#sle.
 - 4. IKO Industries Inc.: www.iko.com/#sle.

5. Owens Corning Corp: www.owenscorning.com.
6. Tamko Roofing Products, Inc.: www.tamko.com.
7. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ASPHALT SHINGLES

- A. Asphalt Shingles: Asphalt-coated glass felt, mineral granule surfaced, complying with ASTM D3462/D3462M.
 1. Fire Resistance: Class A, complying with ASTM E108.
 2. Wind Resistance: Class F, minimum, when tested in accordance with ASTM D3161/D3161M.
 3. Fire or Wind Resistance Criteria: Provide UL (DIR) listed and labeled products.
 4. Warranted Wind Speed: Not greater than 110 mph.
 5. Algae resistant.
 6. Self-sealing type.
 7. Style and Color: Match existing.

2.03 SHEET MATERIALS

- A. Eave Protection Membrane: Self-adhering polymer-modified asphalt sheet complying with ASTM D1970/D1970M; 40 mil total thickness; with strippable treated release paper and polyethylene sheet top surface.
 1. Acceptable Manufacturers:
 - a. GCP Applied Technologies; Ice & Water Shield: www.gcpat.com.
 - b. Polyguard Products, Inc.; Deck Guard: www.polyguard.com.
 - c. Manufacturer's proprietary or recommended product required to maintain specified warranty; compatible with specified underlayment materials.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.04 FLASHINGS

- A. Metal Flashings: Prefinished galvanized steel; see Section 07 6200.
- B. Flexible Flashing: Self-adhering polymer-modified asphalt sheet complying with ASTM D1970/D1970M; 40-mil, 0.040-inch total thickness; with strippable treated release paper and polyethylene sheet top surface.
 1. Acceptable Products:
 - a. GCP Applied Technologies; Ice & Water Shield: www.gcpat.com.
 - b. Polyguard Products, Inc.; Deck Guard: www.polyguardproducts.com.
 - c. Manufacturer's proprietary or recommended product required to maintain specified warranty; compatible with specified underlayment materials.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.05 ACCESSORIES

- A. Roofing Nails: Standard round wire shingle type, galvanized steel, minimum 3/8-inch head diameter, 12-gauge, 0.109-inch nail shank diameter, 1-1/2 inches long and complying with ASTM F1667/F1667M.
- B. Ridge Vents: Plastic, formed with vent openings that do not permit direct water or weather entry; flanged to receive shingles; manufacturer's proprietary or recommended vent accessory product required to maintain specified warranty, and to provide ridge ventilation free area per lineal foot as calculated on Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that roof deck is of sufficient thickness to accept fasteners.
- B. Verify that roof penetrations and plumbing stacks are in place and flashed to deck surface.
- C. Verify roof openings are correctly framed.
- D. Verify deck surfaces are dry, free of ridges, warps, or voids.

3.02 PREPARATION

- A. Seal roof deck joints wider than 1/16 inch as recommended by shingle manufacturer.
- B. At areas where eave protection membrane is to be adhered to substrate, fill knot holes and surface cracks with latex filler.
- C. Broom clean deck surfaces before installing underlayment or eave protection.
- D. Protect surrounding areas and adjacent surfaces from damage during execution of this work.
- E. Install eave edge and gable edge flashings tight with fascia boards, weather lap joints 2 inches and seal with roof cement, and secure flange with nails spaced maximum 12 inches on center.
 - 1. Secure at spacing required or recommended by reference standards specified in Section 07 6200.

3.03 INSTALLATION

- A. Underlayment:
 - 1. Roof Slopes Greater Than 4:12: Install underlayment perpendicular to slope of roof, with ends and edges weather lapped minimum 4 inches; stagger end laps of each consecutive layer, nail in place, and weather lap minimum 4 inches over eave protection.
 - 2. Weather lap and seal watertight with plastic cement any items projecting through or mounted on roof.
- B. Valley Protection:
 - 1. Install valley protection in accordance with SMACNA (ASMM), Figure 4-10.
 - 2. At Exposed Valleys: Install one layer of sheet metal flashing, minimum 24 inches wide, centered over open valley and crimped to guide water flow. Weather lap joints minimum 2-inch wide band of lap cement along each edge of first layer, press roll roofing into cement, and nail in place minimum 18 inches on center and 1 inch from edges.
- C. Metal Flashing:
 - 1. Install flashings in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
 - 2. Weather lap joints minimum 2 inches and seal weather tight with plastic cement.
 - 3. Secure in place with nails at maximum 12 inches on center, and conceal fastenings.
 - 4. Items Projecting Through or Mounted on Roofing: Flash and seal weather tight with plastic cement.

D. Shingles:

1. Install shingles in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
 - a. Fasten individual shingles using two nails per shingle, or as required by manufacturer and local building code, whichever is greater.
 - b. Fasten strip shingles using four nails per strip, or as required by manufacturer and local building code, whichever is greater.
2. Place shingles in straight coursing pattern with minimum 5-inch weather exposure, unless otherwise required by shingle manufacturer for specified shingle product, to produce double thickness over full roof area, and provide double course of shingles at eaves.
3. Project first course of shingles 3/4 inch beyond fascia boards.
4. Extend shingles 1/2 inch beyond face of gable edge fascia boards.
5. After installation, place one daub of plastic cement 1-inch diameter under each individual shingle tab exposed to weather to prevent lifting.
6. Coordinate installation of roof mounted components or work projecting through roof with weathertight placement of counterflashings.
7. Complete installation to provide weathertight service.

3.04 CLEANING

- A. Clean exposed work upon completion of installation; remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to finish.

3.05 PROTECTION

- A. Do not permit traffic over finished roof surface; protect roofing until completion of project.
- B. Touch-up, repair, or replace damaged asphalt shingles or accessories before Date of Substantial Completion.

END OF SECTION

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**SECTION 07 4646
FIBER-CEMENT SIDING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fiber cement siding systems, including:
 - 1. Siding panels.
 - 2. Soffit panels.
 - 3. Facia boards.
 - 4. Accessories and trim.

1.02 REFERENCE STANDARDS

- A. ASTM C1185 - Standard Test Methods for Sampling and Testing Non-Asbestos Fiber-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards.
- B. ASTM C1186 - Standard Specification for Flat Fiber Cement Sheets.
- C. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- F. ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
 - 1. Manufacturer's requirements for related materials to be installed by others.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Manufacturer's detailed installation manual, including requirements for all installation methods, including fastening requirements, flashing requirements, and termination details.
- C. Maintenance Instructions: Periodic inspection recommendations and maintenance procedures.
- D. Warranty: Submit copy of manufacturer's warranty, made out in Owner's name, showing that it has been registered with manufacturer.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of type specified in this Section with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store materials in manufacturer's unopened packaging, with labels intact, until ready for installation.
- B. Store materials under dry and waterproof cover, well ventilated, and elevated above grade on a flat surface.
- C. Protect materials from harmful environmental elements, construction dust, and other potentially detrimental conditions.

1.06 FIELD CONDITIONS

- A. Do not install panels when air temperature or relative humidity are outside manufacturer's limits.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.
- C. Provide manufacturer's standard limited, transferable warranties for each system component specified.
 - 1. Fiber Cement Siding System Components and Standard Trim Profile, Factory Primed: 50 years.
 - 2. Fiber Cement Siding Trim, 4/4 and 5/4 Profiles: 25 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design Manufacturer - Fiber Cement Siding:
 - 1. James Hardie Building Products, Inc.: www.jameshardie.com.
 - a. Siding System: Hardie Artisan Siding with Lock Joint.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Other Acceptable Manufacturers:
 - 1. Allura, a division of Plycem USA, Inc.: www.allurausa.com.
 - 2. CertainTeed Corporation: www.certainteed.com.
 - 3. Nichiha USA, Inc.: www.nichiha.com.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FIBER-CEMENT SIDING

- A. Fiber Cement Siding: Individual boards made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C1186, Type A, Grade II; with machined edges.
 - 1. Surface Burning Characteristics: Flame spread index of 0, smoke developed index of 6, maximum; when tested in accordance with ASTM E84 (Class I/A).
 - 2. Flammability: Noncombustible, when tested in accordance with ASTM E136.
 - 3. Fly Ash Content: None; not permitted.
 - 4. Flexural Strength: At least 1450 psi when in equilibrium condition, and at least 1015 psi when in wet condition, tested in accordance with ASTM C1185.

5. Water Vapor Transmission: Less than 7.0 perm-inch, when tested in accordance with ASTM E96/E96M.
6. Freeze Thaw Resistance: At least 80 percent flexural strength retained, when tested in accordance with ASTM C1185.
7. UV Resistance: No cracking, checking, or erosion, when tested for 2000 hours in accordance with ASTM G155.
8. Water Tightness: No water droplets on underside, when tested in accordance with ASTM C1185.

B. Horizontal Lap Siding: Individual boards with specified face texture and finish.

1. Style: Beveled channel.
2. Texture: Cedarmill.
3. Length: 12 ft, nominal.
4. Width (Exposure): 7 inchwings.
5. Thickness: 7/16 inch, nominal.
6. Finish: Factory applied primer.

C. Soffit Panels: Individual boards with specified face texture and finish.

1. Thickness: 5/16 inch, nominal.
2. Style: Cedarmill texture, widths as detailed on Drawings; continuously vented as indicated on Drawings.
3. Finish: Factory applied primer.
4. Manufacturer: Same as siding.

D. Facia Boards: Individual boards with specified face texture and finish.

1. Thickness: 5/16 inch, nominal.
2. Style: Cedarmill texture, widths as detailed on Drawings.
3. Finish: Factory applied primer.
4. Manufacturer: Same as siding.

2.03 ACCESSORIES

A. Furring Strips - Wood: Specified in Section 06 1053; preservative treated (PT).

B. Fiber Cement Trim: Fiber cement board, provided in nominal sizes as indicated on Drawings, cut edges primed; 5/4 inch nominal thickness.

1. Same material and texture as siding.

C. Fasteners: Galvanized or corrosion resistant type; length as required to penetrate minimum 1-1/4 inch into solid backing, except as otherwise specified.

1. Use of siding manufacturer's recommended fasteners is required, to establish and maintain specified warranty, and for proper and complete installation.

D. Sealant: Elastomeric, polyurethane or silyl-terminated polyether/polyurethane, or as otherwise recommended by siding system manufacturer; capable of being painted. Comply with general requirements specified in Section 07 9200.

E. Insect Screen Mesh: Vinyl-coated fiberglass, 18 x 16 mesh.

F. Sheet Metal Flashing: Specified in Section 07 6200.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrate, clean and repair as required to eliminate conditions that would be detrimental to proper installation.
- B. Verify that air barrier system has been installed over substrate completely and correctly.
- C. Do not begin until unacceptable conditions have been corrected.
- D. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Protect surrounding areas and adjacent surfaces during execution of this work.
- B. Prime or pre-paint field-cut edges prior to installation.
- C. Install sheet metal flashing properly lapped with other components of the weather barrier system, and properly sloped to drain and weep moisture to the exterior.
 - 1. Above door and window trim and casings.
 - 2. Above horizontal trim in field of siding.
 - 3. Components specifically required or recommended by siding manufacturer for installation conditions indicated.
 - a. Include kick-out flashing at locations where eave edges intersect approximately perpendicular to vertical wall surfaces on which fiber cement siding is indicated. Comply with siding manufacturers standard details if details are not otherwise indicated.
 - 4. Install insect screen mesh at bottom and open edges of installations.

3.03 INSTALLATION

- A. Install siding system in accordance with manufacturer's instructions and recommendations, including wood furring strips if required to establish and maintain specified warranty.
 - 1. Read warranty and comply with terms necessary to maintain warranty coverage.
 - 2. Install in accordance with conditions stated in model code evaluation report applicable to location of project.
 - 3. Use trim details indicated on Drawings; if trim details are not indicated, comply with siding manufacturer's standard details in all respects for conditions indicated.
 - 4. Touch up field cut edges before installing.
 - 5. Pre-drill nail holes if necessary to prevent breakage.
- B. Over Foam Insulation: Read and comply with sheathing manufacturer's recommendations.
 - 1. For insulation greater than 1 inch thickness, install furring strips over studs and fasten siding through furring and into studs using load-bearing fasteners spaced as required for load-bearing support of siding system..
- C. Allow space for thermal movement between both ends of siding panels that butt against trim; seal joint between panel and trim with specified sealant.

- D. Joints in Horizontal Siding: Avoid joints in lap siding except at corners; where joints are inevitable stagger joints between successive courses.
 - 1. Provide sheet flashing behind joints, extending minimum 1 inch above top of siding course, minimum 3 inch each side of joint, and minimum 1 inch overlap with previous siding course, or as otherwise required by siding manufacturer.
- E. Minimum Fastener Penetration: Comply with applicable code, but at minimum as follows:
 - 1. Wood Sheathing: 1 inch.
 - 2. Metal Studs: 3 full threads.
- F. Do not install siding less than 6 inches from surface of ground nor closer than 2 inches to roofs, patios, porches, sidewalks, and other surfaces where water may collect, unless otherwise specifically allowed by siding manufacturer or otherwise detailed on Drawings to comply with siding manufacturer's recommendations.
- G. Sealants: After siding system installation, seal all joints except lap joints of lap siding and other joints not required to be sealed according to system manufacturer's installation instructions. Seal around all penetrations through panel system.
 - 1. Exceptions: Do not seal joints between siding components and sheet metal flashings, between bottom edge of siding panels and adjacent materials, and similar locations where moisture must be allowed to weep out from behind siding system.
- H. Finish Painting: Specified in Section 09 9113.

3.04 CLEANING

- A. See Section 01 7000 - Execution and Closeout Requirements for additional requirements.
- B. Clean faced panels in accordance with manufacturer's maintenance instructions, using cleaning materials and methods acceptable to manufacturer.

3.05 PROTECTION

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

END OF SECTION

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SECTION 07 6200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items, including:
 - 1. High-slope roofing system flashings and trim.
 - 2. Gutters.
 - 3. Downspouts.
 - 4. Sheet metal flashing and trim accessories.
 - 5. Other sheet metal flashing and trim items indicated on Drawings and not specified in other Sections.
- B. Sealants for joints within sheet metal fabrications.
- C. Design of attachment systems to comply with specified requirements.

1.02 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- B. ANSI/SPRI/FM 4435/ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- E. ASTM D4479/D4479M - Standard Specification for Asphalt Roof Coatings - Asbestos-Free.
- F. SMACNA (ASMM) - Architectural Sheet Metal Manual.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with roofing work for scheduling installation of counterflashing, rain drainage and similar items related to roofing.
 - 2. Coordinate with the work of Section 07 9200 for installation of related sealants.
- B. Sequencing: Do not proceed with installation of flashing and sheet metal work until substrate construction, cants, blocking, reglets, and other construction are ready to receive the work of this Section.

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) requirements and standard details, except as otherwise indicated or specified.
- B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Extended Correction Period: Correct defective Work within a two year period after Date of Substantial Completion. Defective work includes failure of watertightness or seals.
- C. Manufacturer Warranty: Provide 20 year manufacturer warranty for prefinished sheet metal materials. Include coverage of degradation of metal finish beyond manufacturer's published limits.

PART 2 PRODUCTS

2.01 SHEET METAL FLASHING AND TRIM ASSEMBLIES

- A. General: Design sheet metal flashing and trim assemblies to physically protect roofing systems, roof accessories, and other building elements and systems from damage that would permit water leakage to building interior under all weather conditions.
- B. Flashing Assemblies: Design flashing assemblies to withstand structural movement, thermally induced movement, and exposure to wind and weather without failure or permanent deformation.
- C. Roof Edge Flashing and Coping Assemblies: Design assemblies to comply with the following requirements.
 - 1. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1, RE-1, RE-2, and RE-3 as applicable to positive and negative design wind pressure as defined by applicable code.
 - 2. Movement: Capable of withstanding structural movement, thermally induced movement, and exposure to wind and weather without failure or permanent deformation.

2.02 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal.
 - 1. Applications: Flashings and counterflashings at roofing locations, concealed from public view, and similar locations.
- B. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal, shop pre-coated with PVDF coating.
 - 1. Applications: Flashings and counterflashings exposed to public view, and where specifically indicated on Drawings.

2. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
3. Color: As selected by Architect from manufacturer's full colors.

2.03 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Fabricate cleats and starter strips of same material as exposed sheet, one gage thickness heavier than exposed sheet, and interlockable with exposed sheet.
 1. Provide continuous cleat strips for metal copings and flashings.
- C. Form pieces in longest possible lengths.
- D. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- E. Form material with lapped seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- F. Fabricate corners from one piece with minimum 18-inch long legs; seam for rigidity, seal with sealant.
- G. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.
- H. Fabricate flashings to allow toe to extend minimum 2 inches over roofing terminations. Return and brake edges.
- I. Valley Flashings: Fabricate valleys with one inch high splash diverter ridge at flowline. Extend metal flashings under edges of roofing system adjoining valley intersection minimum 12 inches, and lap ends 6 inches minimum. Fold long edges of flashing approximately 30 degrees, and minimum 1/2 inch high for cleats.
 1. Comply with SMACNA (ASMM) Figure 4-10.
- J. Flashings for Shingle Roofs: Fabricate miscellaneous metal flashings according to the following SMACNA (ASMM) details or as recommended by tile manufacturer:
 1. Roof Penetrations: Figure 8-8 and 8-9 (pipes); Figure 8-12 (vents).
 2. Eave and Rake Flashings: Figure 4-18.
 3. Kick-out Flashings: According to SMACNA (ASMM) standards, or as otherwise detailed on Drawings.
- K. Provide for thermal expansion/contraction of all exposed sheet metal work exceeding 15 feet in running length, except as otherwise indicated.
 1. Valleys and Gutters: 40 feet maximum spacing, and located at high points in drainage wherever possible. One-piece gutters may be up to 60 feet long.
 2. Flashings and Trim: 10 feet maximum spacing, and not closer than 24 inches from corners and intersections.

2.04 GUTTERS AND DOWNSPOUTS

- A. Gutters and Downspouts: Form to profiles as required to properly collect and remove water. Fabricate complete with required connection pieces to maintain watertight joints.
 1. Gutters: Comply with SMACNA (ASMM) Figure 1-12.
 2. Downspouts: Comply with SMACNA (ASMM) Figures 1-32E/1-32H.
 3. Size as indicated on Drawings.

- B. Accessories: Profiled to suit gutters and downspouts.
 - 1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
 - 2. Gutter Supports: Brackets.
 - 3. Downspout Supports: Straps; configured to provide 1/2 inch clear spacing from wall surface.
 - C. Seal metal joints.
- 2.05 ACCESSORIES
- A. Fasteners: Same material and finish as flashing metal, with soft neoprene washers.
 - B. Primer Type: Zinc chromate.
 - C. Protective Backing Paint: Asphaltic mastic, ASTM D4479/D4497M, Type I.
 - D. Concealed Sealants: Non-curing butyl sealant; compatible with metals and roofing system membranes.
 - 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.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.
- C. Metal Wall Caps and Copings: Verify that wood grounds and nailing boards are secured to building framing sufficiently to resist specified pull-off resistance requirements.

3.02 PREPARATION

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

3.03 INSTALLATION - GENERAL

- A. Conform to Drawing details; if not detailed on Drawings, comply with standard details of the following:
 - 1. Steel Sheet Metal: SMACNA (ASMM).
- B. Lapped Seams - General: Overlap seams 4 inches, and seal with two continuous beads of non-curing butyl sealant spaced 2 inches apart and located 1 inch from end of each metal sheet.
- C. Cleats and Edge Strips: Secure edges of sheet metal members over 12 inches wide, and at other indicated locations with cleats. Fasten cleats at maximum 12 inches on center unless otherwise indicated. Provide continuous edge strips at eaves and gable ends for attaching exposed terminating edge of copings, gravel stops, or fascias. Provide minimum 1/8 inch butt joints as required to accommodate thermal movement.
- D. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.
- E. Apply compatible sealant between metal flashings and roofing system flashings.

- F. Isolate sheet metal from cementitious materials and dissimilar metals with underlayment or protective coating that is compatible with all other materials with which it will come in contact.
 - G. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
 - H. Seal metal joints watertight.
- 3.04 INSTALLATION - PRE-FINISHED SHEET METAL
- A. Take special care in the handling and installation to avoid damage to finish.
 - B. Remove protective film from each unit after installation, but not before adjacent construction is complete.
 - C. Touch up minor damage or defects to match factory finish. Replace units which are excessively damaged as determined by Architect.
- 3.05 INSTALLATION - GUTTERS AND DOWNSPOUTS
- A. Install as recommended by SMACNA (ASMM) and manufacturer. Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts.
 - B. Apply bituminous paint on surfaces to be in contact with dissimilar materials.
 - C. Slope gutters minimum 1/8 inch per foot.
 - D. Secure downspouts to wall with 3 inch wide steel straps, spaced not more than 8 feet oc. Fasten straps or clamps to building with non-corrosive expansion screws.
 - E. Connect downspouts to storm sewer system.

END OF SECTION

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**SECTION 07 7139
GABLE VENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured roof ventilation specialties, including:
 - 1. Attic ventilation components.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate installation of components of this Section with installation of wall cladding systems and flashings.
 - 2. Coordinate installation of sealants with work of this Section to ensure water tightness.

1.03 SUBMITTALS

- A. See Section 01 3000 - 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. Manufacturer's Installation Instructions: Indicate special procedures, fasteners, supporting members, and perimeter conditions requiring special attention.

PART 2 PRODUCTS

2.01 VENTILATION COMPONENTS

- A. Gable Vents: Molded copolymer, with UV stabilized color throughout; insect screen and nailing flanges; configurations as shown on Drawings.
 - 1. Color: As selected from manufacturer's full line.
 - 2. Acceptable Product:
 - a. The Tapco Group; GableMaster: www.midamericacomponents.com.
 - b. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ACCESSORIES

- A. Sealant for Joints in Linear Components: As recommended by component manufacturer.
- B. Attachments: As recommended by manufacturer for indicated applications.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install components in accordance with manufacturer's instructions.

B. Anchor components securely. Seal weathertight to substrates.

END OF SECTION

**SECTION 07 8400
FIRESTOPPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems, materials, and accessories.
- B. Firestopping at electrical junction boxes in fire-rated walls.
- C. Firestopping of all penetrations and interruptions to fire rated assemblies, whether indicated on Drawings or not, and other openings indicated.
- D. Contractor's responsibility for determining required scope of firestopping system work, and for determining applicable tested/listed systems for the entire project, and for securing jurisdictional authority approval of firestopping systems.

1.02 REFERENCE STANDARDS

- A. ASTM E90
- B. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- C. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
- D. ASTM E1399 - Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.
- E. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- H. IFC (GUIDE) - International Firestop Council Recommended Guidelines for Evaluating Firestop Systems Engineering Judgements; current edition.
- I. ITS (DIR) - Directory of Listed Products.
- J. FCIA - Firestop Contractors International Association Manual of Practice; current edition.
- K. FM (AG) - FM Approval Guide.
- L. UL 1479 - Standard for Fire Tests of Penetration Firestops.
- M. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems.
- N. UL (DIR) - Online Certifications Directory.
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
- P. UL (FRD) - Fire Resistance Directory.
- Q. UL 1479 - Standard for Fire Tests of Through-Penetration Firestops.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate installation of firestopping systems with affected trades and adjacent work.
- B. Sequencing: Sequence work to permit firestopping materials to be installed after adjacent and surrounding work is complete.
 - 1. Do not cover or conceal firestopping installations until jurisdictional authority have inspected each installation.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- D. Jurisdictional Authority Submittal: After review and approval of specified submittals by Architect, submit to jurisdictional authority and local fire department complete product data indicating proposed product characteristics, performance characteristics, limitation criteria, and documentation of proposed firestop materials and systems for actual project conditions.
 - 1. Include manufacturer's complete installation instructions and UL Design or other approved testing agency data sheets for each proposed firestop system.
 - 2. Include complete test data forms or jurisdictional acceptance for proposed assemblies not conforming to specific UL Design numbers or other approved testing agency system designs.
 - 3. Submit certificate from authority having jurisdiction indicating approval of materials and systems to be used, with one complete copy, for information only, of the approved jurisdictional authority submittal.

1.05 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), FM (AG), or ITS (DIR) 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. Installer Qualifications: Company specializing in performing the work of this Section and:
 - 1. Trained by manufacturer.
 - 2. Approved by Factory Mutual Research Corporation under FM 4991, or meeting any two of the following requirements:
 - a. Verification of minimum three years documented experience installing work of this type.
 - b. Verification of at least five satisfactorily completed projects of comparable size and type.
 - c. Licensed by local authorities having jurisdiction (AHJ).
- C. Obtain firestop systems for each type and condition of penetration from a single manufacturer; intermixing of system components for each type and condition of penetration by different manufacturers is not permitted.

- D. Listed and tested assemblies and systems must be utilized, if they exist, before alternative systems requiring Engineering Judgement (EJ) or Equivalent Fire Resistance Rated Assembly (EFRRA) will be considered. Comply with IFC (GUIDE) and FCIA for EJ and EFRRA design and submittal requirements.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Deliver materials in original unopened containers identified with manufacturer's brand designation and applicable UL label.
- B. Do not use damaged or expired materials.

1.07 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.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer Warranty: Include agreement to repair or replace joint sealers which fail in joint adhesion, extrusion resistance, migration resistance, general durability, or apparent deterioration beyond manufacturer's printed limitations for stipulated warranty period from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 1. 3M Fire Protection Products: www.3m.com/firestop.
 2. A/D Fire Protection Systems Inc.: www.adfire.com.
 3. Everkem Diversified Products, Inc.: www.everkemproducts.com/#sle.
 4. GCP Applied Technologies: www.gcpat.com.
 5. Hilti, Inc.: www.hilti.com/#sle.
 6. Nelson FireStop Products: www.nelsonfirestop.com.
 7. Pecora Corporation: www.pecora.com.
 8. RectorSeal: www.rectorseal.com.
 9. Specified Technologies Inc.: www.stifirestop.com/#sle.
 10. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
 11. USG: www.usg.com.
 12. Substitutions: See Section 01 6000 - Product Requirements.

2.02 MATERIALS - GENERAL

- A. Firestopping Materials: Any materials meeting requirements specified.
 1. Comply with ASTM E814, UL 1479, and UL 2079 as applicable to achieve indicated fire ratings.
- B. Mold and Mildew Resistance: Provide firestopping materials with mold and mildew resistance rating of zero(0) in accordance with ASTM G21.

- C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- D. Fire Ratings: Refer to Drawings for required systems and ratings.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. General: Use firestopping systems which are acceptable for those applications for which they are specifically designed. Use of other UL listed systems is Contractor's Option, subject to compliance with specified performance, regulatory, and quality assurance requirements.
 - 1. Where there is no specific tested and classified firestop system for an indicated condition, obtain from the firestopping system manufacturer an Engineering Judgement (EJ) or Equivalent Fire Resistance Rated Assembly (EFRR) according to IFC (GUIDE) and FCIA.
- B. Scope: Install firestopping at all locations requiring protected openings where piping, conduit, cables, sleeves, ductwork and similar items penetrate fire-resistive, fire-rated, and smoke assemblies, including but not limited to:
 - 1. Penetrations through wall assemblies, including empty openings and openings containing penetrations.
 - 2. Membrane penetrations where items penetrate one side of the barrier assembly.
 - 3. Joints between rated assemblies to allow independent movement.
 - 4. Joints, through-penetrations, and membrane penetrations in smoke-rated assemblies.
- C. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
- D. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
 - 1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
 - 2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
 - 3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
 - 4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.
- E. Acoustically Rated Firestopping: Provide system tested in accordance with ASTM E90 with STC rating of 50, minimum.
- F. Fire Rated Construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces and types of construction, at separations required to permit building movement and sound or vibration absorption, and at other construction gaps.
- G. Smoke Barrier Construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations, connections with other surfaces and types of construction, at separations required to permit building movement and sound or vibration absorption, and at other construction gaps.
- H. Other General Characteristics:
 - 1. Surface Burning: ASTM E84 and UL 723; flame spread less than 25, smoke developed less than 450.
 - 2. Air Leakage of Perimeter Firestopping Barriers and Penetrations: UL 2079; L-rating less than 2.0 cfm/sf or 5.0 cfm/lf as applicable to the type and location of joint.
 - 3. Durability and Longevity: Permanent.

4. Side Effects During Installation: Non-toxic.
5. Side Effects Under Fire Exposure: Non-toxic.
6. Long Term Side Effects: None.

2.04 MATERIALS

- A. Putty Compound: 100 percent solids intumescent or vinyl-type formulation, free of asbestos, silicones, solvents, halogens, PCB's, and inorganic fibers; flame spread/smoke developed rating 0/0 when tested in accordance with ASTM E84; paintable, not sensitive to freezing after set.
- B. Sealant Compound: One-part intumescent, endothermic, ablative, or elastomeric acrylic water-based caulking material required by applicable UL Design; flame spread/smoke developed rating 0/0 when tested in accordance with ASTM E84.
- C. Spray-Applied Compound: Water-based, flexible coating which dries to form a flexible seal; tested in accordance with ASTM E1399, complying with wind sway and thermal category, 500 cycles at minimum 10 cycles/minute.
- D. Foam Compound: Two-part, liquid-silicone elastomer formulated to foam in place when mixed; flame spread/smoke developed rating 0/0 when tested in accordance with ASTM E84.
- E. Plastic Pipe Device: Intumescent strip material, factory or site fabricated in flexible metal collar with adjustable, screw-tightened stainless steel clamp; UL classified for use with PVC, CPVC, CCPVC, CCABS, PVDF, PP, PB, and FRPP plastic pipe.
- F. Fire-Safing Insulation: ASTM C612, Type I; high-melt mineral fibers and resinous binders formed into blankets, density not less than 4.0 lbs/cu ft, tested for 3-hour fire containment for required depths and dimensions.
- G. Firestopping Pads: Intumescent, dielectric fire putty formed to 7 by 7 or 9.5 by 9.5 inch self-adhering pads, 2-hour fire rating listed by UL.

2.05 ACCESSORIES

- A. Provide necessary accessory materials specified in UL Design to achieve complete firestop system at each penetration. Include collars, sleeves, attachment devices, intumescent materials, and other items required.
- B. Primers, Sleeves, Forms, and Accessories: Type required for tested assembly design, and as recommended by firestopping manufacturer for specific substrate surfaces.
- C. Dam Material: Mineral fiberboard, mineral fiber matting, sheet metal, alumina silicate fire board, or other permanent material required as part of the firestopping system, or removable if not specifically required as part of the firestopping system.
- D. Retainers: Impale type clips to support mineral fiber safing blankets.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 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 or damming materials required to arrest liquid material leakage.

3.03 INSTALLATION - GENERAL

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Apply firestopping materials in sufficient thicknesses to achieve scheduled fire ratings, to uniform density and texture.
- C. Install material at openings which contain penetrating sleeves, piping, ductwork, conduit and other items requiring firestopping.
- D. Remove dam material after firestopping material has cured only if dam material is not required as part of the firestopping system; otherwise dam material to remain permanently in place.
- E. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- F. Install labeling required by code.

3.04 INSTALLATION - FIRE SAFING INSULATION

- A. Install safing insulation to completely fill spaces between floor slab edges and spandrel construction as detailed.
- B. Install safing insulation to completely fill voids between floor and roof deck flutes and top of wall construction where wall ratings are indicated.
- C. Install and support safing insulation permanently in position to comply with tested fire assembly and applicable building code requirements.

3.05 INSTALLATION - FIRESTOPPING PADS

- A. Install firestopping pads on back side of electrical junction boxes in fire-rated walls where boxes are located in same stud space on opposite sides of same wall, and elsewhere required by jurisdictional authority and local fire department.

3.06 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.07 PROTECTION

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

END OF SECTION

**SECTION 07 9200
JOINT SEALANTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Joint sealants, including:
 - 1. Nonsag gunnable joint sealants.
 - 2. Self-leveling gunnable and pourable joint sealants.
- B. Joint backings and accessories.
- C. Field quality control of sealant installations, including:
 - 1. Post-occupancy inspection.

1.02 DEFINITIONS

- A. Nonsag Sealant: Permits application in joints on vertical surfaces without sagging or slumping.
- B. Self-leveling Sealant: Pourable or self-leveling sealant that has sufficient flow to form a smooth, level surface when applied in a horizontal joint.

1.03 REFERENCE STANDARDS

- A. ASTM C1472 - Standard Guide for Calculating Movement and Other Effects When Establishing Sealant Joint Width.
- B. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
- C. ASTM C834 - Standard Specification for Latex Sealants.
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- E. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- F. ASTM C1311 - Standard Specification for Solvent Release Sealants.
- G. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
- H. SWRI - Sealant, Waterproofing and Restoration Institute; Sealants: The Professionals' Guide; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sealant work with other work requiring sealants, and with other Sections referencing this Section; do not obstruct indicated or required moisture weepage systems under any circumstances.
 - 2. Coordinate sealant surface preparation of exterior joint sealants scheduled for paint finish with Section 09 9113. Provide advice and recommendations on compatibility of specified preparation procedures with sealants used.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Backing material recommended by sealant manufacturer.
 - 4. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 5. Substrates the product should not be used on.
 - 6. Substrates for which use of primer is required.
- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- D. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.

1.06 QUALITY ASSURANCE

- A. Conform to SWRI recommendations for materials and installation.
- B. Installer Qualifications: Company specializing in performing the work of this Section with minimum three years documented experience.
- C. System Compatibility: Assume responsibility for confirming that sealants are compatible with each other as a system, and also compatible with substrate surfaces with which they will be in contact, including but not limited to wall and sheathing surfaces, opening materials, other flashings and weather barrier materials.
 - 1. Assure that system components are compatible as specified prior to preparing and making specified submittals.
 - 2. Assume responsibility for removal of incompatible system components and installation of properly compatible components at no additional cost to Owner regardless of when incompatibility is discovered.

1.07 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.
 - 1. Install sealants only when temperature is in lower third of manufacturer's recommended installation temperature range wherever joint width is affected by ambient temperature variations.
 - 2. Install sealants only when ambient temperature conditions can be maintained at or above 40 degrees F during installation and 48 hours immediately following installation.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in original, unopened containers or bundles with labels indicating manufacturer, product name and designation, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

- B. **Manufacturer Warranty:** Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.
- C. **Extended Correction Period:** Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. **Acceptable Manufacturers - Joint Sealants:** Following manufacturer's are generally acceptable for sealant types specified in this Section, subject to compliance with other specified requirements.
 - 1. Adhesives Technology Corporation: www.atcepoxy.com/#sle.
 - 2. Bostik Inc.: www.bostik-us.com/#sle.
 - 3. Dow: www.dow.com/#sle.
 - 4. Hilti, Inc.: www.us.hilti.com/#sle.
 - 5. Master Builders Solutions: www.master-builders-solutions.com/en-us/#sle.
 - 6. Momentive Performance Materials, Inc. (formerly GE Silicones): www.momentive.com/#sle.
 - 7. Pecora Corporation: www.pecora.com/#sle.
 - 8. Sika Corporation: www.usa.sika.com/#sle.
 - 9. Tremco Global Sealants: www.tremcosealants.com/#sle.
 - 10. W.R. Meadows, Inc.: www.wrmeadows.com/#sle.
 - 11. Substitutions: See Section 01 6000 - Product Requirements.
- B. **Source Limitations:** Furnish products of this Section produced by single manufacturer for each sealant and accessory type and application, subject to compliance with system compatibility requirements specified in this Section.

2.02 JOINT SEALANT APPLICATIONS

- A. **Sealant Scope:**
 - 1. **Exterior Joints:**
 - a. Seal open joints except open joints indicated on Drawings as not sealed.
 - b. Also seal the following joints, unless otherwise indicated as not sealed:
 - 1) Wall expansion and control joints.
 - 2) Joints between doors, windows, and other frames or adjacent construction.
 - 3) Joints between different exposed materials.
 - 4) Other joints as detailed on Drawings.
 - 2. **Interior Joints:**
 - a. Do not seal through-penetrations in sound-rated assemblies that are also fire-rated assemblies.
 - b. Seal open joints except specific open joints indicated on Drawings as not sealed.
 - c. Also seal the following joints, unless otherwise indicated as not sealed:
 - 1) Joints between door frames and window frames and adjacent construction.
 - 2) In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping penetrations, and other openings.
 - 3) In sound-rated wall and ceiling assemblies, seal joints between wall assemblies and ceiling assemblies; between wall assemblies and other construction; between ceiling assemblies and other construction.

3. Do Not Seal:
 - a. Intentional weep holes in masonry, and weep systems in windows, storefronts, curtainwalls, and similar fenestration elements.
 - b. Joints indicated to be covered with manufactured expansion joint cover assemblies or other sealing devices.
 - c. Joints where sealant is specified to be furnished and installed by manufacturer of product to be sealed.
 - d. Joints where sealant installation is specified in other Sections.
- B. Exterior Joints: Use nonsag nonstaining silicone sealant, unless otherwise indicated.
 1. Lap Joints in Sheet Metal Fabrications: Butyl rubber, non-curing.
 2. Control and Expansion Joints in Concrete Paving: Self-leveling polyurethane "traffic-grade" sealant.
- C. Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.
 1. Wall and Ceiling Joints in Non-Wet Areas: Acrylic emulsion latex sealant.
 2. Wall and Ceiling Joints in Wet Areas: Non-sag polyurethane sealant for continuous liquid immersion.
 3. Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant.
- D. Definitions of Special Use Areas:
 1. Interior Wet Areas: Include restrooms and kitchens; fixtures in wet areas include plumbing fixtures, countertops, cabinets, and other similar items.

2.03 JOINT SEALANTS - GENERAL

- A. Hardness: As recommended by manufacturer for applications shown.
- B. Modulus of Elasticity: Provide lowest available modulus of elasticity for indicated requirements and consistent with exposure to weathering, indentation, abrasion and support of loading.
- C. Compatibility: Provide sealants, joint fillers, and related materials that are compatible with one another and with substrates and other materials to which they will be exposed in the joint system.
- D. Grade: For each application, provide grade of sealant complying with ASTM C920, and as recommended by manufacturer for indicated conditions, to achieve best possible performance. Types, grades, classes, and uses specified are for normal conditions.
- E. Colors: As selected from manufacturer's full line, unless otherwise specified.

2.04 NONSAG JOINT SEALANTS

- A. Nonstaining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 1. Movement Capability: Plus and minus 50 percent, minimum.
 2. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 3. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
 4. Cure Type: Single-component, neutral moisture curing.
 5. Service Temperature Range: Minus 20 to 180 degrees F.
 6. Acceptable Products:
 - a. Adfast USA Inc; Adseal DWS 4580 Series: www.adfastcorp.com/#sle.
 - b. Dow; DOWSIL 791 Silicone Weatherproofing Sealant: www.dow.com/#sle.

- c. Momentive Performance Materials, Inc./GE Silicones; SCS9000 SilPruf NB - Non-Staining Silicone Weatherproofing Sealant: www.siliconeforbuilding.com/#sle.
 - d. Pecora Corporation; Pecora 890 NST (Non-Staining Technology): www.pecora.com/#sle.
 - e. Sika Corporation; Sikasil 728NS: www.usa.sika.com/#sle.
 - f. Tremco Commercial Sealants & Waterproofing; Spectrem 2: www.tremcosealants.com/#sle.
 - g. Substitutions: See Section 01 6000 - Product Requirements.
- B. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
- 1. Color: White.
 - 2. Acceptable Products:
 - a. Adfast USA Inc.; ADSEAL KB 4800 Series: www.adfastcorp.com/#sle.
 - b. Everkem Diversified Products, Inc.; TruSil 100: www.everkemproducts.com/#sle.
 - c. Pecora Corporation; Pecora 898 NST (Non-Staining Technology): www.pecora.com/#sle.
 - d. Sika Corporation; Sikasil GP: www.usa.sika.com/#sle.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
- C. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
- 1. Movement Capability: Plus and minus 50 percent, minimum.
 - 2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 - 3. Service Temperature Range: Minus 40 to 180 degrees F.
 - 4. Acceptable Products:
 - a. Master Builders Solutions; MasterSeal NP1: www.master-builders-solutions.com/en-us/#sle.
 - b. Pecora Corporation; DynaTrol II: www.pecora.com/#sle.
 - c. Sika Corporation; Sikaflex-2c NS: www.usa.sika.com/#sle.
 - d. Tremco Commercial Sealants & Waterproofing; Dymonic 100: www.tremcosealants.com/#sle.
 - e. Substitutions: See Section 01 6000 - Product Requirements.
- D. Polyurethane Sealant for Continuous Water Immersion: ASTM C920, Grade NS, Uses M and A; single or multicomponent; explicitly approved by manufacturer for continuous water immersion; suitable for traffic exposure when recessed below traffic surface.
- 1. Movement Capability: Plus and minus 35 percent, minimum.
 - 2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 - 3. Service Temperature Range: Minus 40 to 180 degrees F.
 - 4. Acceptable Products:
 - a. Sika Corporation; Sikaflex-1a: www.usa.sika.com/#sle.
 - b. Sika Corporation; Sikaflex-2c NS: www.usa.sika.com/#sle.
 - c. Substitutions: See Section 01 6000 - Product Requirements.
- E. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.
- 1. Grade: ASTM C834; Grade 0 Degrees F (Minus 18 Degrees C).
 - 2. Acceptable Products:
 - a. Everkem Diversified Products, Inc.; SilTex 40: www.everkemproducts.com/#sle.
 - b. Franklin International, Inc.; Titebond Pro-Grade Plus Caulk: www.titebond.com/#sle.
 - c. Pecora Corporation; AC-20 +Silicone: www.pecora.com/#sle.

- d. Sherwin-Williams Company; 950A Siliconized Acrylic Latex Caulk: www.sherwin-williams.com/#sle.
- e. Specified Technologies Inc.; Smoke N' Sound Acoustical Sealant: www.stifirestop.com/#sle.
- f. Top Gun, a brand of PPG Architectural Coatings; Top Gun 200: www.ppgpaints.com/#sle.
- g. Tremco Commercial Sealants & Waterproofing; Tremflex 834: www.tremcosealants.com/#sle.
- h. Substitutions: See Section 01 6000 - Product Requirements.

F. Non-Curing Butyl Sealant: Solvent-based, single component, non-sag, non-skinning, non-hardening, non-bleeding; non-vapor-permeable; intended for fully concealed applications.

- 1. Acceptable Products:
 - a. Pecora Corporation; Pecora BA-98 Non-Skinning Butyl Sealant: www.pecora.com/#sle.
 - b. Tremco Commercial Sealants & Waterproofing; Acoustical/Curtainwall Sealant: www.tremcosealants.com/#sle.
 - c. Substitutions: See Section 01 6000 - Product Requirements.

2.05 SELF-LEVELING JOINT SEALANTS

A. Self-Leveling Silicone Sealant: ASTM C920, Grade P, Uses M and A; single or multicomponent, explicitly approved by manufacturer for traffic exposure when recessed below traffic surface; not expected to withstand continuous water immersion.

- 1. Movement Capability: Plus 100 percent, minus 50 percent, minimum.
- 2. Hardness Range: 0 to 15, Shore A, when tested in accordance with ASTM C661.
- 3. Service Temperature Range: Minus 40 to 180 degrees F.
- 4. Acceptable Products:
 - a. Dow; DOWSIL SL Parking Structure Sealant: www.dow.com/#sle.
 - b. Everkem Diversified Products, Inc.; Hi-Temp Silicone: www.everkemproducts.com/#sle.
 - c. Pecora Corporation; Pecora 300 SL (Self-Leveling): www.pecora.com/#sle.
 - d. Sika Corporation; Sikasil 728SL: www.usa.sika.com/#sle.
 - e. Tremco Commercial Sealants & Waterproofing; Spectrem 900SL: www.tremcosealants.com/#sle.
 - f. Substitutions: See Section 01 6000 - Product Requirements.

2.06 ACCESSORIES

A. Sealant Backing Materials - General: Materials placed in joint before applying sealants; assists sealant performance and service life by developing optimum sealant profile and preventing three-sided adhesion; use type and size recommended by sealant manufacturer for compatibility with sealant, substrate, and indicated applications.

- 1. Sealant Backing Rod, Closed-Cell Type:
 - a. Cylindrical flexible sealant backings complying with ASTM C1330 Type C.
 - b. Size: 25 to 50 percent larger in diameter than joint width.
 - c. Applications: Exterior sealant joints, unless specifically recommended otherwise by sealant manufacturer for indicated application.
- 2. Sealant Backing Rod, Open-Cell Type:
 - a. Cylindrical flexible sealant backings complying with ASTM C1330 Type O.
 - b. Size: 25 to 50 percent larger in diameter than joint width.
 - c. Applications: Interior sealant joints, unless specifically recommended otherwise by sealant manufacturer for indicated application.

3. Sealant Backing Rod, Bi-Cellular Type:
 - a. Cylindrical flexible sealant backings complying with ASTM C1330 Type B.
 - b. Size: 25 to 50 percent larger in diameter than joint width.
 - c. Applications: Interior and exterior sealant joints, unless specifically recommended otherwise by sealant manufacturer for indicated application.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

- A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with ASTM C1193.
- C. 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.
 1. Provide joints sized for width/depth ratios according to ASTM C1472.
- D. Multiple backer rods are not permitted; use single backer rod properly sized to joint width.
- E. Install bond breaker backing tape where backer rod cannot be used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not obstruct indicated or required moisture weepage systems under any circumstances.

- H. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- I. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width, i.e., at low temperature in thermal cycle. Report failures immediately and repair them.

3.05 CLEANING

- A. Clean exposed sealant surfaces immediately prior to Substantial Completion with cleaning solutions or other methods recommended and approved by sealant manufacturer, and which will not stain or damage adjacent surfaces; wipe dry.

3.06 PROTECTION

- A. Protect installed sealants from damage or failed adhesion due to subsequent construction operations.
- B. Do not permit traffic over self-leveling sealants that are exposed to construction or pedestrian traffic until Substantial Completion.

END OF SECTION

SECTION 07 9513
EXPANSION JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion joint cover assemblies for wall, ceiling, and roof surfaces.

1.02 REFERENCE STANDARDS

- A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
- C. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
- D. ITS (DIR) - Directory of Listed Products.
- E. UL (DIR) - Online Certifications Directory.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Installation Templates: For frames and anchors to be embedded in concrete or masonry, furnish templates to relevant installers; include installation instructions and tolerances.
- B. Coordination: Coordinate installation of roof expansion joints with roofing system installation.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide joint assembly profiles, profile dimensions, anchorage devices and available colors and finish.
- C. Shop Drawings: Indicate joint and splice locations, miters, layout of the work, affected adjacent construction and anchorage locations.
- D. Manufacturer's Installation Instructions: Indicate rough-in sizes and required tolerances for item placement.

1.05 QUALITY ASSURANCE

- A. Basis of Design: Specifications and Drawing details are based on joint assemblies by the specified basis of design manufacturer. Types and assemblies manufactured by other acceptable manufacturers are permitted, subject to compliance with performance requirements; and provided that deviations in dimensions, profiles, and configurations are minor, and do not detract substantially from the indicated design intent.
 - 1. Comply with requirements specified in Section 01 4000 and Section 01 6000.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design Manufacturer:
 - 1. Manufacturer and products as specified on Drawings.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 EXPANSION JOINT COVER ASSEMBLIES

- A. Expansion Joint Cover Assemblies - General: Factory-fabricated and assembled; designed to completely fill joint openings, sealed to prevent passage of air, dust, water, smoke; suitable for traffic expected.
 - 1. Joint Dimensions and Configurations: As indicated on Drawings.
 - 2. Joint Cover Sizes: Selected to suit joint width and configuration, based on manufacturer's published recommendations and limitations.
 - 3. Joint Cover Styles: As indicated on Drawings.
 - 4. Joint Movement Capability: If not indicated, provide minimum plus/minus 25 percent joint movement capability.
 - 5. Lengths: Provide covers in full lengths required; avoid splicing wherever possible.
 - 6. Anchors, Fasteners, and Fittings: Provided by cover manufacturer.
- B. Resilient Seal Type Covers: Having flat exposed surface without crevices that could collect dirt; designed to withstand expected movement without extrusion of seal from joint assembly; for floors, provide style that is flush with top of floor covering; for exterior joints, weathertight.
- C. Covers in Gypsum Board Assemblies: Provide style with anchoring wings that can be completely covered by joint compound.
- D. Covers in Fire Rated Assemblies: Provide cover assembly having fire rating equivalent to that of assembly into which it is installed.
 - 1. Acceptable Evaluation Agencies: UL (DIR) and ITS (DIR).

2.03 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper; or ASTM B308/B308M, 6061 alloy, T6 temper.
 - 1. Exposed Finish Outdoors: Natural anodized.
 - 2. Exposed Finish at Walls and Ceilings: Natural anodized.
- B. Resilient Seals:
 - 1. For Ceilings: Any resilient material, flush, pleated, or hollow gasket.
 - 2. Color: Selected by Architect from manufacturer's full line.
- C. Anchors and Fasteners: As recommended by cover manufacturer.
- D. Threaded Fasteners: Stainless steel.
- E. Backing Paint for Aluminum Components in Contact with Cementitious Materials: Asphaltic type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joint preparation and dimensions are acceptable and in accordance with manufacturer's requirements.
- B. Verify that frames and anchors installed by others are in correct locations and suitable for installation of remainder of assembly.

3.02 INSTALLATION

- A. Install components and accessories in accordance with manufacturer's instructions.
- B. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor to substrate to prevent misalignment.

3.03 PROTECTION

- A. Provide strippable coating to protect finish surfaces prior to Substantial Completion.

END OF SECTION

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**SECTION 08 1113
HOLLOW METAL DOORS AND FRAMES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hollow metal doors and frames, including:
 - 1. Non-fire-rated hollow metal doors and frames.
 - 2. Hollow metal frames for wood doors.
 - 3. Fire-rated hollow metal doors and frames.
 - 4. Thermally insulated hollow metal doors with frames.
 - 5. Hollow metal borrowed lites glazing frames.

1.02 DEFINITIONS

- A. NAAMM/HMMA: National Association of Architectural Metal Manufacturers; Hollow Metal Manufacturers Association.
- B. SDI: Steel Door Institute.

1.03 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100).
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
- G. 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.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- I. BHMA A156.115 - American National Standard for Hardware Preparation in Steel Doors and Steel Frames.
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities.
- K. ITS (DIR) - Directory of Listed Products.
- L. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames.
- M. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames.

- N. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames.
- O. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames.
- P. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
- Q. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives.
- R. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.
- S. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames.
- T. UL (DIR) - Online Certifications Directory.
- U. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with wall construction for anchor placement.
 2. Coordinate installation of hardware.
 3. Coordinate installation of glazing.

1.05 SUBMITTALS

- A. See Section 01 3000 - 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. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- C. Inspect hollow metal products upon delivery for damage. Minor damage may be repaired provided refinishing is equal in all respects to new work and is acceptable to Architect; otherwise replace damaged items with new products as specified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Any listed member of SDI or NAAMM/HMMA in good standing; www.steeldoor.org or www.naamm.org/hmma.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 GENERAL DOOR AND FRAME REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 3. 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, unless otherwise indicated on Drawings.
 - 6. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on Drawings.
 - 7. 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.
 - a. Prepare doors and frames for hardware in accordance with templates provided under Section 08 7100.
- 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; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

- A. 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 1 - Full Flush.
 - d. Door Face Metal Thickness: 16 gage, 0.053 inch, minimum.
 - 2. Door Core Material: Polyurethane 1.8 lbs/cu ft minimum density.
 - a. Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.
 - 3. Door Thermal Resistance: R-Value of 8.7, minimum, for installed thickness of polyurethane.
 - 4. Door Thickness: 1-3/4 inches, nominal.
 - 5. Top Closures for Outswinging Doors: Flush with top of faces and edges.
 - 6. Door Finish: Factory primed and field finished.

B. Interior Doors, Non-Fire-Rated:

1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B 500 000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 18 gage, 0.042 inch, minimum.
2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
3. Door Thickness: 1-3/4 inches, nominal.
4. Door Finish: Factory primed and field finished.

C. Interior Doors, Fire-Rated:

1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B 500 000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 18 gage, 0.042 inch, minimum.
2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
 - a. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - b. Attach fire rating label to each fire rated unit.
3. Door Core Material: Manufacturers standard core material/construction in compliance with requirements.
4. Door Thickness: 1-3/4 inches, nominal.
5. Door Finish: Factory primed and field finished.

2.04 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Exterior Door Frames: Full profile/continuously welded type.
1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A60/ZF180 coating.
 2. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
 3. Frame Finish: Factory primed and field finished.
 4. Weatherstripping: Separate, see Section 08 7100.
- C. Interior Door Frames, Non-Fire Rated: Face welded type.
1. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 2. Frame Finish: Factory primed and field finished.
- D. Interior Door Frames, Fire-Rated: Face welded type.
1. Fire Rating: Same as door, labeled.
 2. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 3. Frame Finish: Factory primed and field finished.
- E. Frames for Wood Doors: Comply with general interior metal frame requirements in accordance with corresponding wood door; minimum 18 gauge thickness, unless otherwise indicated.

- F. Borrowed Lites Glazing Frames: Construction and face dimensions to match typical interior metal door frames, and as indicated on Drawings; minimum 18 gauge thickness, unless otherwise indicated.

2.05 FINISHES

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

2.06 ACCESSORIES

- A. Glazing: As specified in Section 08 8000.
- B. Removable Stops: Formed sheet steel, shape as indicated on Drawings, mitered corners; prepared for countersink style tamper proof screws.
- 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

3.01 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.

3.02 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions, regulatory requirements, and related requirements of specified door and frame standards or custom guidelines indicated.
 - 1. Install fire rated units in accordance with NFPA 80.
 - 2. Install smoke control frame and door assemblies in accordance with NFPA 105.
- B. Install door hardware as specified in Section 08 7100.

3.03 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 (Warp): 1/8 inch measured with straight edge, corner to corner.

3.04 ADJUSTING

- A. Adjust for smooth and balanced door movement.

3.05 SCHEDULE

- A. See Door and Frame Schedule on Drawings.

END OF SECTION

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**SECTION 08 1416
FLUSH WOOD DOORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush wood doors, including:
 - 1. Interior wood doors.

1.02 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards.
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 3.1.
- C. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.
- D. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.
- E. WDMA I.S. 1A - Interior Architectural Wood Flush Doors.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with door opening construction, door frame and door hardware installation.
 - 2. Coordinate installation of glazing.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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 accepted manufacturer's stain color selector guide.
 - 1. After initial color selection, submit two samples 12 by 12 inch in size illustrating selected stain color, face veneers, and specified finishes.

1.05 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.
- B. Obtain all doors of each type specified from a single manufacturer to assure uniformity of appearance and construction.

1.06 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, and inspect for damage.

- C. Protect doors with resilient packaging sealed with heat shrunk plastic; do not store in damp or wet areas or areas where sunlight might bleach veneer; seal top and bottom edges with tinted sealer if stored more than one week, and break seal on site to permit ventilation.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer's warranty on interior doors for the life of the installation. Complete forms in Owner's name and register with manufacturer.
 - 1. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Algoma Hardwoods, Inc.: www.algomahardwoods.com.
 - 2. Haley Brothers: www.haleybros.com/#sle.
 - 3. Masonite Architectural: www.architectural.masonite.com/#sle.
 - 4. Oregon Door: www.oregondoor.com/#sle.
 - 5. VT Industries, Inc.: www.vtindustries.com/#sle.
 - 6. Substitutions: See Section 01 6000 - Product Requirements.

2.02 DOORS

- A. Doors: Refer to Drawings for locations and additional requirements.
 - 1. Quality Standard: Premium Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS), AWMAC/WI (NAAWS) or WDMA I.S. 1A.
 - 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
- 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 closed.
 - 3. Smoke and Draft Control Doors: In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch wg pressure at both ambient and elevated temperatures for "S" label; if necessary, provide additional gasketing or edge sealing.
 - 4. Provide following types at locations as scheduled on Drawings:
 - a. Wood veneer facing with factory transparent finish.

2.03 DOOR AND PANEL CORES

- A. General Requirement: Provide door cores fully bonded to stiles and rails.
- B. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.

- C. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.04 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: Species as selected by Architect, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with slip match between leaves of veneer, balance match of spliced veneer leaves assembled on door or panel face.
 - 1. Vertical Edges: Same species as face veneer, solid wood edges, minimum 0.25 inch thick.
 - 2. "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.

2.05 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.
 - a. Provide solid blocking for other throughbolted hardware.
 - 2. Provide minimum 6 inch high solid wood top rail and minimum 16 inch high solid wood bottom rail, all doors; fire-resistant treated at fire-rated doors.
- 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.

2.06 FACTORY FINISHING - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 - 1. Transparent:
 - a. System - 11, Polyurethane, Catalyzed.
 - b. Stain: As selected by Architect.
 - c. Sheen: Satin.
- B. Finish work in accordance with WDMA I.S. 1A for grade specified and as follows:
 - 1. Transparent:
 - a. System - TR-6, Catalyzed Polyurethane.
 - b. Stain: As selected by Architect.
 - c. Sheen: Satin.
- C. Factory finish doors in accordance with approved sample.

2.07 ACCESSORIES

- A. Hollow Metal Door Frames: See Section 08 1113.
- B. Glazing: See Section 08 8000.

- C. Glazing Stops - Non-Rated Doors: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.
- D. Door Hardware: See Section 08 7100.

PART 3 EXECUTION

3.01 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.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions, regulatory requirements, and specified quality standard.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Adjust width of non-rated doors by cutting equally on both jamb edges.
 - 1. Trim maximum of 3/4 inch off bottom edges.
 - 2. Trim fire-rated doors in strict compliance with fire rating limitations.
- D. Use machine tools to cut or drill for hardware.

3.03 TOLERANCES

- A. Comply with specified quality standard for fit and clearance tolerances.
- B. Comply with specified quality standard for telegraphing, warp, and squareness.
- C. Maximum Undercut at Fire-Rated Doors: 3/4 inch clearance to non-combustible finish floor surface.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.
- C. Restore finish on all edges of shop finished doors before installation, if fitting or machining is required on site.

3.05 SCHEDULE

- A. See Door and Frame Schedule on the Drawings.

END OF SECTION

**SECTION 08 3100
ACCESS DOORS AND PANELS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall- and ceiling-mounted access units.

1.02 REFERENCE STANDARDS

- A. ITS (DIR) - Directory of Listed Products.
- B. UL (FRD) - Fire Resistance Directory.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate installation with work of other trades, and obtain information on door sizes and exact locations from other trades.
 - 2. Coordinate placement of rough-in openings with Architect in tiled walls and gypsum board ceilings.
 - 3. Coordinate placement of access doors and panels with locations of toilet partitions and urinal screens so that doors or panels are not placed in conflict with partition or screen locations.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- C. Manufacturer's Installation Instructions: Indicate installation requirements and rough-in dimensions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com/#sle.
 - 2. ACUDOR Products Inc.: www.acudor.com/#sle.
 - 3. Babcock-Davis: www.babcockdavis.com/sle.
 - 4. Best Access Doors: www.bestaccessdoors.com/#sle.
 - 5. Cendrex, Inc.: www.cendrex.com.
 - 6. Elmdor Stonemen: www.elmdorstoneman.com/#sle.
 - 7. FF Systems, Inc.: www.ffsystemsinc.com/#sle.
 - 8. Karp Associates, Inc.: www.karpinc.com.
 - 9. MIFAB, Inc.: www.mifab.com/#sle.
 - 10. Milcor by Commercial Products Group of Hart & Cooley, Inc.: www.milcorinc.com.
 - 11. Nystrom, Inc.: www.nystrom.com/sle.
 - 12. Studco Building Systems: www.studcosystems.com/#sle.
 - 13. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ACCESS DOOR AND PANEL ASSEMBLIES

A. Wall-Mounted Units:

1. Panel Material: Steel; prime painted.
2. Size: 12 inch by 12 inch, unless otherwise indicated on Drawings.
3. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
4. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
5. Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface flush with wall surface.

B. Walls in Wet Areas:

1. Panel Material: Stainless steel, Type 304.
2. Size: 12 inch by 12 inch, unless otherwise indicated on Drawings.
3. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
4. In All Wall Types: Surface mounted face frame and door surface flush with frame surface; gasketed door to frame all 4 sides.
5. Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface flush with wall surface.

C. Fire Rated Walls: See Drawings for wall fire ratings.

1. Panel Material: Steel; prime painted.
2. Size: 12 inch by 12 inch, unless otherwise indicated on Drawings.
3. Door/Panel: Insulated double-surface panel, with tool-operated spring or cam lock and no handle.

D. Ceilings, Unless Otherwise Indicated: Same type as for walls in corresponding functional locations.

2.03 WALL- AND CEILING-MOUNTED ACCESS UNITS

A. Wall- and Ceiling-Mounted Units: Factory-fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.

1. Door Style: Single thickness with rolled or turned in edges.
2. Frames: 16-gauge, 0.0598-inch minimum thickness.
3. Single Steel Sheet Door Panels: 16-gauge, 0.0625-inch minimum thickness.
4. Units in Fire-Rated Assemblies: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
 - a. Provide products listed by ITS (DIR) or UL (FRD) as suitable for purpose indicated.
5. Steel Finish: Primed.
6. Stainless Steel Finish: No.4 brushed finish.
7. Hardware:
 - a. Hinge for Fire-Rated-Units: 175 degree steel hinges with non-removable pin.
 - b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
 - c. Latch/Lock: Tamperproof tool-operated cam latch.
 - d. Number of Locks/Latches Required: As recommended by manufacturer for size of unit.
 - e. Gasketing: Extruded neoprene, around perimeter of door panel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings are correctly sized and located.
- B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Review access panel locations during wall framing rough-in to confirm location is coordinated with interior wall finishes.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to proceeding with this work.
- B. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings, and secure units rigidly in place.
- C. Position units to provide convenient access to concealed equipment when necessary.
- D. Adjust hardware and panels for proper operation.
- E. Wet Locations: Seal frame to host wall all around; clear silicone sealant as specified in Section 07 9200.

END OF SECTION

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SECTION 08 4313
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed storefront framing system.
- B. Aluminum doors and frames.
 - 1. Weatherstripping.
- C. Design engineering of framing system and load-bearing connections to building structural frame system.

1.02 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site.
- B. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
- C. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document).
- D. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
- E. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- G. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- H. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
- I. ASTM D4479/D4479M - Standard Specification for Asphalt Roof Coatings - Asbestos-Free.
- J. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- K. 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.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate attachment and seal of perimeter air and vapor barrier materials.
 - 2. Coordinate with installation of other components that comprise the exterior enclosure.

1.04 SUBMITTALS

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

- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, door hardware, and internal drainage details.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- D. Samples: Submit two samples 12 inches long illustrating finished aluminum surface.
- E. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
- F. Field Quality Control Submittals: Report of field testing for water penetration.

1.05 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 at Colorado.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store 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.

1.07 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.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Extended Correction Period: Correct defective Work within a two year period after Date of Substantial Completion.
- C. Manufacturer Warranty: Provide ten year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design Manufacturer:
 1. Substitutions: See Section 01 6000 - Product Requirements.
- B. Acceptable Manufacturers:
 1. Arcadia, Inc.: www.arcadiainc.com/#sle.
 2. Kawneer North America: www.kawneer.com/#sle.
 3. Manko Window Systems, Inc.: www.mankowindows.com/#sle.
 4. Oldcastle BuildingEnvelope: www.oldcastlebe.com/#sle.

5. Tubelite, Inc.: www.tubeliteinc.com/#sle.
6. Trulite Glass & Aluminum Solutions, LLC: www.trulite.com/#sle.
7. YKK AP America, Inc.: www.ykkap.com/commercial/#sle.
8. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ALUMINUM-FRAMED STOREFRONT SYSTEM

- 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, unless otherwise indicated for interior applications.
 - a. Interior Glazing Rabbet: For 1/4 inch monolithic glazing.
 2. Glazing Position: Centered (front to back).
 3. Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
 4. Finish: Superior performing organic coating.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
 - c. Finish Color: Match existing "green" color.
 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.
 - a. Fabricate individual system frame members, comp heads, sill pans, and other system components in single, continuous pieces; splices are not permitted unless specifically required by project installation conditions.
 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.
 11. Maintain continuous air barrier and/or vapor retarder seal throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel, and heel bead of glazing compound.

2.03 PERFORMANCE REQUIREMENTS

- A. Design Requirements: 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.
1. Design Wind Loads: Comply with requirements of applicable code.
 2. Member Deflection: Limit member deflection to L/175 of clear span, 3/4 inch total, or to flexure limit of glass in any direction, whichever is less, with full recovery of glazing materials.
 3. Provide reinforced mullion sections as may be required to comply with specified design requirements, for manufacturer's specified system.

- B. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 10 psf.
- C. Thermal Performance Requirements:
 - 1. Condensation Resistance Factor of Framing: 60, minimum, measured in accordance with AAMA 1503.
 - 2. Overall U-factor Including Glazing: Maximum values.
 - a. Fixed Glazing: 0.38.
 - b. Entrance Doors: 0.77.

2.04 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 - 1. Framing members for interior applications need not be thermally broken.
 - 2. Glazing Stops: Flush.
 - 3. Corner and Closure Assemblies: Fabricated from manufacturer's standard aluminum sheet of minimum thickness required for indicated span conditions; warping and oil-canning appearance not permitted.
 - a. 90-Degree Corners: Manufacturer's standard combination of two pocket corner extrusions.
 - b. Corners Other Than 90 Degrees: Manufacturer's standard varying degree pocket corner extrusions with aluminum sheet metal fillers and closures.
 - 4. Structurally Reinforced Members: Extruded aluminum with internal reinforcement of structural steel member.
 - a. As required or recommended by manufacturer for indicated loading requirements using manufacturer's standard profile of extruded aluminum with internal reinforcement of steel shaped structural section.
- B. Glazing: See Section 08 8000.
- C. Swing Doors: Glazed aluminum; nominal stile and rail dimensions as follows:
 - 1. Thickness: 1-3/4 inches.
 - 2. Top Rail: 3-1/2 inches wide.
 - 3. Vertical Stiles: 3-1/2 inches wide.
 - 4. Bottom Rail: 10 inches wide.
 - 5. Glazing Stops: Square.
 - 6. Finish: Same as storefront.
 - 7. Design exterior doors for one inch insulating glass units and thermally broken, and interior doors for 1/4 inch glass and non-thermally broken.
- D. Exterior Mullion Caps: Manufacturer's standard extrusions designed for installation on exterior mullions; sizes, shapes, and configurations as indicated on Drawings.

2.05 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet Aluminum: ASTM B209 (ASTM B209M); minimum thicknesses as follows:
 - 1. Corner and Closure Assemblies: Aluminum sheet, 20 gauge, 0.032 inch minimum thickness; finish to match framing members.

2. Exposed Flashings: Aluminum sheet, 20 gauge, 0.032 inch minimum thickness; finish to match framing members.
 3. Concealed Flashings: Sheet aluminum, 26 gauge, 0.017 inch minimum thickness.
- C. Fasteners: Stainless steel.
- D. Sill Pan Flashing Sealant: Elastomeric, silicone or polyurethane, compatible with flashing material.
- E. Glazing Gaskets: As recommended by storefront manufacturer; type to suit application to achieve weather, moisture, and air infiltration requirements.
1. Size gaskets as required by manufacturer of glazing channel frame to provide proper pressure and bite on glazing units.
 2. Coordinate with glazing requirements specified in Section 08 8000 - Glazing.
- F. Glazing Accessories: See Section 08 8000.

2.06 ACCESSORIES

- A. Reinforcement: Where fasteners screw-anchor into aluminum less than 1/8 inch thick, reinforce the interior with aluminum or non-magnetic stainless steel to receive screw threads, or provide standard non-corrosive, pressed-in splined grommet nuts.
- B. Brackets: High-strength aluminum brackets and reinforcements where possible; otherwise provide non-magnetic stainless steel or galvanized steel complying with ASTM A123/A123M.
- C. Sill Pans: Manufacturer's standard extruded profile, thermally broken, designed to direct moisture to the exterior at sill conditions; including splice sleeves and continuously sealed end dams.
1. Provide with sill pan clips for installation without the use of penetrating fasteners.
- D. Comp-Heads: Manufacturer's standard extruded profile, thermally broken, designed to accommodate minimum one inch deflection of building elements at head conditions.
- E. Water Deflectors: Manufacturer's standard internal system accessory specifically designed to route internal water drainage away from top surfaces of insulated glass units.
- F. Expansion Anchors: Stainless steel, drilled-in type expansion bolts for required attachment to concrete or masonry.
- G. Protective Backing Paint: Asphaltic mastic, ASTM D4479/D4479M, Type I.
- H. Internal System Sealants and Gaskets: As recommended by manufacturer for use within the framing system for fabrication, assembly, and installation. Use products which will remain permanently elastic, non-shrinking, and waterproof.

2.07 FINISHES

- A. Superior Performing Organic Coatings System: Manufacturer's standard multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent polyvinylidene fluoride (PVDF) resin, and at least 80 percent of aluminum extrusion and panels surfaces having minimum total dry film thickness (DFT) of 1.2 mils, 0.0012 inch.
- B. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.08 HARDWARE

- A. For each door, include weatherstripping and sill sweep strip by door manufacturer.

- B. Other Door Hardware: See Section 08 7100.
- C. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.
- D. Sill Sweep Strips: Resilient seal type, retracting, of silicone or EPDM; provide on all doors.
- E. Reinforce components internally for door hardware and door operators.
- F. Finishing: Apply factory finish to all surfaces that will be exposed in completed assemblies, including exposed fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this Section.

3.02 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- G. Install sill pans with end dams; do not obstruct weep paths with sealants. Locate sill pan joints, if required, minimum 12 inches from centerline of vertical mullions. Seal to adjacent work to form water tight dam.
- H. Install comp-head units where detailed; do not secure comp-heads to primary storefront head frames.
- I. Install internal system sealants as installation progresses. Seal sill pan splices, end dams, water deflectors, and other components to ensure that proper water weepage paths are established and maintained within the system.
- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch per 3 feet 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.

- C. Location: Limit variation from plane or dimensioned location to 1/8 inch in 12 feet, non-cumulative, and 1/2 inch in overall length of member.

3.04 FIELD QUALITY CONTROL

- A. Provide services of storefront manufacturer's field representative to observe for proper installation of system and submit report.
- B. See Section 01 4000 - Quality Requirements for independent field testing and inspection requirements, and requirements for monitoring quality of specified product installations.
- C. Provide field testing of installed storefront system by AAMA accredited independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as directed by Architect.
 - 2. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 10 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.
- D. Repair or replace storefront components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.05 ADJUSTING

- A. Adjust operating hardware and sash for smooth operation.

3.06 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.
- C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.07 PROTECTION

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

END OF SECTION

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**SECTION 087100
DOOR HARDWARE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hardware for wood and aluminum doors.
- B. Thresholds.
- C. Weatherstripping and gasketing.

1.02 RELATED REQUIREMENTS

- A. Section 081116 - Aluminum Doors and Frames.
- B. Section 081213 - Hollow Metal Frames.
- C. Section 081416 - Flush Wood Doors.
- D. Section 081433 - Stile and Rail Wood Doors.
- E. Section 084313 - Aluminum-Framed Storefronts: Door hardware, except as noted in section.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.
- C. BHMA A156.1 - Standard for Butts and Hinges; 2021.
- D. BHMA A156.2 - Bored and Preassembled Locks and Latches; 2022.
- E. BHMA A156.3 - Exit Devices; 2020.
- F. BHMA A156.4 - Door Controls - Closers; 2019.
- G. BHMA A156.6 - Standard for Architectural Door Trim; 2021.
- H. BHMA A156.7 - Template Hinge Dimensions; 2016.
- I. BHMA A156.8 - Door Controls - Overhead Stops and Holders; 2021.
- J. BHMA A156.16 - Auxiliary Hardware; 2018.
- K. BHMA A156.21 - Thresholds; 2019.
- L. BHMA A156.22 - Standard for Gasketing; 2021.
- M. BHMA A156.26 - Standard for Continuous Hinges; 2021.
- N. BHMA A156.28 - Standard for Recommended Practices for Mechanical Keying Systems; 2018.
- O. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames; 2016.
- P. BHMA A156.115W - Hardware Preparation in Wood Doors with Wood or Steel Frames; 2006.
- Q. DHI (H&S) - Sequence and Format for the Hardware Schedule; 2019.
- R. DHI (KSN) - Keying Systems and Nomenclature; 2019.
- S. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; 2004.
- T. DHI WDHS.3 - Recommended Locations for Architectural Hardware for Flush Wood Doors; 1993; also in WDHS-1/WDHS-5 Series, 1996.
- U. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- V. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- W. ITS (DIR) - Directory of Listed Products; Current Edition.

- X. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
- Y. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2022.
- Z. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- AA. UL (DIR) - Online Certifications Directory; Current Edition.
- BB. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- CC. UL 437 - Standard for Key Locks; Current Edition, Including All Revisions.
- DD. UL 1037 - Antitheft Alarms and Devices; Current Edition, Including All Revisions.
- EE. UL 1610 - Central-Station Burglar-Alarm Units; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
- B. Sequence installation to ensure facility services connections are achieved in an orderly and expeditious manner.
- C. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; require attendance by affected installers and the following:
 - 1. Architect.
 - 2. Installer's Architectural Hardware Consultant (AHC).
 - 3. Hardware Installer.
 - 4. Owner's Security Consultant.
- D. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- E. Keying Requirements Meeting:
 - 1. Schedule meeting at project site prior to Contractor occupancy.
 - 2. Attendance Required:
 - a. Contractor.
 - b. Owner.
 - c. Door Hardware Installer.
 - d. Owner's Security Consultant.
 - 3. Agenda:
 - a. Establish keying requirements.
 - b. Verify locksets and locking hardware are functionally correct for project requirements.
 - c. Verify that keying and programming complies with project requirements.
 - d. Establish keying submittal schedule and update requirements.
 - 4. Incorporate "Keying Requirements Meeting" decisions into keying submittal upon review of door hardware keying system including, but not limited to, the following:
 - a. Access control requirements.
 - b. Key control system requirements.
 - 5. 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.
 - 6. Deliver established keying requirements to manufacturers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- C. Shop Drawings - Door Hardware Schedule: A detailed listing that includes each item of hardware to be installed on each door.

1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 2. Comply with DHI (H&S) using door numbering scheme and hardware set numbers as indicated in Contract Documents.
 - a. Submit in vertical format.
 3. Include complete description for each door listed.
- D. Shop Drawings - Electrified Door Hardware: Include diagrams for power, signal, and control wiring for electrified door hardware that include details of interface with building safety and security systems. Provide elevations and diagrams for each electrified door opening as follows:
1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 2. Elevations: Include front and back elevations of each door opening showing electrified devices with connections installed and an operations narrative describing how opening operates from either side at any given time.
 3. Diagrams: Include point-to-point wiring diagrams that show each device in door opening system with related colored wire connections to each device.
- E. Samples for Verification:
1. Submit minimum size of 2 by 4 inch (51 by 102 mm) for sheet samples, and minimum length of 4 inch (102 mm) for other products.
 2. Submit one (1) sample of hinge, lockset, and closer illustrating style, color, and finish.
 3. Architect will return full-size samples to Contractor.
 4. Include product description with samples.
- F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.
- I. Supplier's qualification statement.
- J. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- K. Keying Schedule:
1. Submit three (3) copies of Keying Schedule in compliance with requirements established during Keying Requirements Meeting unless otherwise indicated.
- L. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- M. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
- N. Maintenance Materials and Tools: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

- A. Standards for Fire-Rated Doors: Maintain one copy of each referenced standard on site, for use by Architect and Contractor.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least three years of documented experience.
- D. Supplier Qualifications: Company with certified Architectural Hardware Consultant (AHC) to assist in work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer warranty against defects in material and workmanship for period indicated, from Date of Substantial Completion. Complete forms in Owner's name and register with manufacturer.
 - 1. Closers: Limited lifetime, minimum.
 - 2. Exit Devices: Limited lifetime, minimum.
 - 3. Locksets and Cylinders: Three years, minimum.
 - 4. Other Hardware: Two years, minimum.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B. Provide individual items of single type, of same model, and by same manufacturer.
- C. Closers:
 - 1. Provide door closer on each exterior door, unless otherwise indicated.
 - 2. Provide door closer on each fire-rated and smoke-rated door.
 - 3. Spring hinges are not an acceptable self-closing device, unless otherwise indicated.
- D. Overhead Stops and Holders (Door Checks):
 - 1. Provide stop for every swinging door, unless otherwise indicated.
 - 2. Overhead Stop is not required if positive stop feature is specified for door closer; positive stop feature of door closer is not an acceptable substitute for a stop, unless otherwise indicated.
 - 3. Overhead stop is not required if a floor or wall stop has been specified for the door.
- E. Drip Guards: Provide at head of outswinging exterior doors unless protected by roof or canopy directly overhead.
- F. Weatherstripping and Gasketing:
- G. Fasteners:
 - 1. Provide fasteners of proper type, size, quantity, and finish that comply with commercially recognized standards for proposed applications.
 - a. Aluminum fasteners are not permitted.
 - b. Provide phillips flat-head screws with heads finished to match door surface hardware unless otherwise indicated.
 - 2. Provide machine screws for attachment to reinforced hollow metal and aluminum frames.
 - a. Self-drilling (Tek) type screws are not permitted.
 - 3. Provide stainless steel machine screws and lead expansion shields for concrete and masonry substrates.
 - 4. Provide wall grip inserts for hollow wall construction.
 - 5. Fire-Resistance-Rated Applications: Comply with NFPA 80.
 - a. Provide wood or machine screws for hinges mortised to doors or frames, strike plates to frames, and closers to doors and frames.
 - b. Provide steel through bolts for attachment of surface mounted closers, hinges, or exit devices to door panels unless proper door blocking is provided.

2.02 PERFORMANCE REQUIREMENTS

- A. Provide door hardware products that comply with the following requirements:
 - 1. Applicable provisions of federal, state, and local codes.

2. Accessibility: ADA Standards and ICC A117.1.
3. Fire-Resistance-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
4. Hardware on Fire-Resistance-Rated Doors: Listed and classified by UL (DIR), ITS (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for application indicated.
5. Hardware Preparation for Steel Doors and Steel Frames: BHMA A156.115.
6. Hardware Preparation for Wood Doors with Wood or Steel Frames: BHMA A156.115W.
7. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.

2.03 HINGES

- A. Manufacturers: Conventional butt hinges.
 1. BEST; dormakaba Group: www.bestaccess.com/#sle.
 2. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
 1. Butt Hinges: As applicable to each item specified.
 - a. Standard Weight Hinges: Minimum of two (2) permanently lubricated non-detachable bearings.
 - b. Heavy Weight Hinges: Minimum of four (4) permanently lubricated bearings on heavy weight hinges.
 - c. Template screw hole locations.
 - d. Bearing assembly installed after plating.
 - e. Bearings: Exposed fully hardened bearings.
 - f. Bearing Shells: Shapes consistent with barrels.
 - g. Pins: Easily seated, non-rising pins.
 - 1) Fully plate hinge pins.
 - 2) Non-Removable Pins: Slotted stainless steel screws.
 - h. UL 10C listed for fire-resistance-rated doors.
 2. Continuous Hinges: As applicable to each item specified.
 - a. Geared Continuous Hinges: As applicable to each item specified.
 - 1) Non-handed.
 - 2) Anti-spinning through-fastener.
 - 3) UL 10C listed for fire-resistance-rated doors.
 - (a) Metal Door Installation: Rated up to 90 minutes.
 - (b) Wood Door Installation: Rated up to 60 minutes.
 - 4) Sufficient size to permit door to swing 180 degrees
- C. Sizes: See Door Hardware Schedule.
 1. Hinge Widths: As required to clear surrounding trim.
 2. Sufficient size to allow 180 degree swing of door.
- D. Finishes: See Door Hardware Schedule.
 1. Fully polish hinges; front, back, and barrel.
- E. Grades:
 1. Butt Hinges: Comply with BHMA A156.1 and BHMA A156.7 for templated hinges.
 2. Continuous Hinges: Comply with BHMA A156.26, Grade 1.
- F. Material: Base metal as indicated for each item by BHMA material and finish designation.
- G. Types:
 1. Butt Hinges: Include full mortise hinges.
 2. Continuous Hinges: Include geared hinges.
- H. Quantities:

1. Butt Hinges: Three (3) hinges per leaves up to 90 inches (2286 mm) in height. Add one (1) for each additional 30 inches (762 mm) in height or fraction thereof.
 - a. Hinge weight and size unless otherwise indicated in hardware sets:
 - 1) For doors up to 36 inches (914 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.134 inch (3.4 mm) and a minimum of 4-1/2 inches (114 mm) in height.
 - 2) For doors from 36 inches (914 mm) wide up to 42 inches (1067 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.145 inch (3.7 mm) and a minimum of 4-1/2 inches (114 mm) in height.
 - 3) For doors from 42 inches (1067 mm) wide up to 48 inches (1219 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.180 inch (4.6 mm) and a minimum of 5 inches (127 mm) in height.
 - 4) For doors greater than 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.180 inch (4.6 mm) and a minimum of 5 inches (127 mm) in height.
 2. Continuous Hinges: One per door leaf.
- I. Applications: At swinging doors.
1. Provide non-removable pins at out-swinging doors with locking hardware and all exterior doors.
- J. Products:
1. Butt Hinges:
 - a. Ball Bearing, Five (5) Knuckle.
 2. Continuous Hinges:
 - a. Aluminum geared hinges.

2.04 BOLTS

- A. Manufacturers:
1. Trimco: www.trimcohardware.com/#sle.
 2. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
1. Flush Bolts:
 - a. Automatic Flush Bolts: Automatically latching upon closing of door leaf.
 - 1) Bolt Throw: 3/4 inch (19 mm), minimum.
 2. Dustproof Strikes: For bolting into floor, provide except at metal thresholds.
- C. Options:
1. Lever extensions: Provide for top bolt at oversized doors.
- D. Products:
1. Automatic flush bolts.

2.05 EXIT DEVICES

- A. Manufacturers:
1. dormakaba commercial, dormakaba Group: www.dormakaba.com/us-en/#sle.
 2. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
1. Actuation: Full-length touchpad.
 2. Touchpads: "T" style metal touchpads and rail assemblies with matching chassis covers end caps.
 3. Latch Bolts: Stainless steel deadlocking with 3/4 inch (19 mm) projection using latch bolt.
 4. Lever Design: Match project standard lockset trims.
 5. Cylinder: Include where cylinder dogging or locking trim is indicated.
 6. Strike as recommended by manufacturer for application indicated.
 7. Dogging:

- a. Non-Fire-Resistance-Rated Devices: Cylinder 1/4 inch (6 mm).
 - b. Fire-Resistance-Rated Devices: Manual dogging not permitted.
- 8. All exposed exit device components to be of architectural metals and "true" architectural finishes.
- 9. Handing: Field-reversible.
- 10. Vertical Latch Assemblies' Operation: Gravity, without use of springs.
- C. Grades: Complying with BHMA A156.3, Grade 1.
- D. Standards Compliance:
 - 1. Provide UL (DIR) listed exit device assemblies for fire-resistance-rated doors.
 - 2. Comply with UL 10C.
- E. Options:
 - 1. MLR: Motorized latch retraction.
 - 2. X touch bar switch.
- F. Products:
 - 1. QED100.

2.06 CYLINDRICAL LOCKS

- A. Manufacturers:
 - 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
 - 1. Mechanical Locks:
 - a. Fitting modified ANSI A115.2 door preparation.
 - b. Door Thickness Fit: 1-3/8 inches (35 mm) to 2-1/4 inches (57 mm) thick doors.
 - c. Construction: Hub, side plate, shrouded rose, locking pin to be a one-piece casting with a shrouded locking lug.
 - 1) Through-bolted anti-rotational studs.
 - d. Cast stainless steel latch retractor with roller bearings for exceptionally smooth operation and superior strength and durability.
 - e. Bored Hole: 2-1/8 inch (54 mm) diameter.
 - f. Backset: 2-3/4 inches (70 mm) unless otherwise indicated.
 - g. Latch: Single piece tail-piece construction.
 - 1) Latchbolt Throw: 9/16 inch (14.3 mm), minimum.
 - h. Cylinders:
 - 1) Cylinder Core Types: Locks capable of supporting manufacturers' cores, as applicable.
 - (a) Small format interchangeable.
 - i. Lever Trim:
 - 1) Style: See Door Hardware Schedule.
 - 2) Functionality: Allow the lever handle to move up to 45 degrees from horizontal position prior to engaging the latchbolt assembly.
 - 3) Strength: Locksets outside locked lever designed to withstand minimum 1,400 inch-lbs (158.2 Nm) of torque. In excess of that, a replaceable part will shear. Key from outside and/or inside lever will still operate lockset.
 - 4) Independent spring mechanism for each lever.
 - (a) Contain lever springs in the main lock hub.
 - 5) Outside Lever Sleeve: Seamless one-piece construction.
 - 6) Keyed Levers: Removable only after core is removed by authorized control key.
- C. Finishes: See Door Hardware Schedule.
 - 1. Core Faces: Match finish of lockset.

- D. Grades: Comply with BHMA A156.2, Grade 1, Series 4000, Operational Grade 1, Extra Heavy Duty.
 - 1. Durability: Passing 50 Million cycle tests verified by third party testing agency.
- E. Material: Manufacturer's standard for specified lock.
 - 1. Critical Latch and Chassis Components: Brass or corrosion-resistance treated steel.
 - 2. Outside Lever Sleeve: Hardened steel alloy.
- F. Products: Cylindrical locks, including mechanical and electrified types.
 - 1. 9K (Grade 1).

2.07 DOOR PULLS AND PUSH PLATES

- A. Manufacturers:
 - 1. Trimco: www.trimcohardware.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
 - 1. Pull Type: Straight, unless otherwise indicated.
 - 2. Push Plate Type: Flat, with square corners, unless otherwise indicated.
 - a. Edges: Beveled, unless otherwise indicated.
- C. Grades: Comply with BHMA A156.6.
- D. Material: Stainless steel, unless otherwise indicated.
- E. Products:
 - 1. Push-Pull Plates.

2.08 COORDINATORS

- A. Manufacturers:
 - 1. Trimco: www.trimcohardware.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
 - 1. General: Non-handed devices, with field-selectable active door leaf.
 - 2. Coordinators: Devices on pairs of doors with closers and self-latching or automatic flush bolts installed.
 - a. Coordinator Operation: Only when inactive door is opened.
- C. Code Compliance: As required by authorities having jurisdiction in the State in which the Project is located.
 - 1. Meet UL 10C for Positive Pressure.
- D. Types:
 - 1. Coordinators: Bar.
- E. Installation:
 - 1. Mounting: Provide necessary mounting brackets and filler bars to ensure proper installation of coordinator and related hardware.
 - 2. Coordination: Properly sequence installation of other door hardware affected by placement of coordinators and carry bars.
- F. Products:
 - 1. 3090 Series.

2.09 CLOSERS

- A. Manufacturers:
 - 1. dormakaba; dormakaba Group: www.dormakaba.com/us-en/#sle.
 - 2. dormakaba commercial, dormakaba Group: www.dormakaba.com/us-en/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
 - 1. Surface Mounted Closers: Manufacturer's standard.

- a. Construction: Cast iron.
 - b. Maximum Projection from Face of Door: 2-7/16 inches (62 mm).
 - c. Mechanism: Separate tamper-resistant adjusting valves for closing and latching speeds.
 - 1) Include delayed action feature.
 - d. Hydraulic Fluid: All-weather type.
 - e. Arm Assembly: Standard for product specified.
 - 1) Include hold-open, integral stop, or spring-loaded stop feature, as specified in Door Hardware Schedule.
 - 2) Parallel arm to be a heavy-duty rigid arm.
 - 3) Where "IS" or "S-IS" arms are specified in hardware sets, if manufacturer does not offer this arm provide a regular arm mount closer in conjunction with a heavy-duty overhead stop equal to a dormakaba 900 Series.
 - f. Covers:
 - 1) Type: Standard for product selected.
 - (a) Full.
 - 2) Material: Plastic.
 - 3) Finish: Painted.
2. Closers Concealed in Door: Manufacturer's standard.
- a. Listed by UL and CUL for fire-resistance-rated doors.
 - b. Tested and approved for compliance with UL 10C for positive pressure.
 - c. Accessibility: Meet ADA Standards and ICC A117.1.
 - d. California State Fire Marshall Approved.
 - e. Cam and roller closers with adjustable spring power.
 - f. Design for installation in the door or inverted in the frame.
 - g. Separate valves for latch speed and sweep speed; accessible with closer installed.
 - h. Adjustable cushioned stop and adjustable hold open where indicated in Door Hardware Schedule.
 - i. Brackets as required to ensure proper installation.
 - j. Auxiliary stop.
3. Closers Concealed in Frame: Manufacturer's standard.
- a. Separate valves for latch speed and sweep speed.
 - b. Built-in pressure relief valve.
 - c. Hold-open functionality as specified in Door Hardware Schedule.
 - d. Brackets as required to ensure proper installation.
 - e. Auxiliary stop.
 - f. Non-handed units.
- C. Grades:
- 1. Closers: Comply with BHMA A156.4, Grade 1.
 - a. Underwriters Laboratories Compliance:
 - 1) Product Listing: UL (DIR) and ULC for use on fire-resistance-rated doors.
 - (a) UL 228 - Door Closers-Holders, With or Without Integral Smoke Detectors.
- D. Types:
- 1. Rack-and-pinion, surface-mounted. 1-1/2 inches (38 mm) minimum bore.
- E. Options:
- 1. Delayed action, adjustable with an independent valve.
 - 2. Advanced backcheck.
- F. Installation:
- 1. Mounting: Includes surface mounted and concealed, overhead mounted installations.
 - 2. Mount closers on non-public side of door and stair side of stair doors unless otherwise noted in hardware sets.
 - 3. At outswinging exterior doors, mount closer on interior side of door.

4. Provide adapter plates, shim spacers, and blade stop spacers as required by frame and door conditions.
5. Where an overlapping astragal is included on pairs of swinging doors, provide coordinator to ensure door leaves close in proper order.

G. Products:

1. Surface Mounted:
 - a. QDC100.
2. Concealed - Overhead:
 - a. ITS96.
 - b. RTS88.

2.10 OVERHEAD STOPS AND HOLDERS

A. Manufacturers:

1. Architectural Builders Hardware Mfg (ABH) www.abhmfg.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

B. Properties:

C. Sizes: Manufacturer's standard for the application.

D. Finishes:

1. Arms and Brackets: Zinc-plated.

E. Grades: As applicable to item specified.

1. Comply with BHMA A156.8, Grade 1.

F. Material: Base metal as indicated for each item by BHMA material and finish designation.

1. Track Channel: Extruded aluminum alloy.
2. Slide Block: Machined from solid brass alloy.

G. Types:

1. Surface-applied.

H. Products:

1. Surface Overhead Stops and Holders:
 - a. ABH: 9000.

2.11 PROTECTION PLATES

A. Manufacturers:

1. Trimco: www.trimcohardware.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

B. Properties:

1. Plates:
 - a. Kick Plates: Provide along bottom edge of push side of every wood door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.
 - b. Mop Plates: Provide along bottom edge of push side of doors to provide protection from cleaning liquids and equipment damage to door surface.
 - c. Edges: Beveled, on four (4) unless otherwise indicated.

C. Grades: Comply with BHMA A156.6.

D. Material: As indicated for each item by BHMA material and finish designation.

1. Metal Properties: Stainless steel.

E. Installation:

1. Fasteners: Countersunk screw fasteners

F. Products:

1. K0050.
2. KM050.

2.12 STOPS AND HOLDERS

- A. Manufacturers:
 - 1. Trimco: www.trimcohardware.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. General: Provide overhead stop/holder when wall or floor stop is not feasible.
- C. Grades:
 - 1. Door Holders, Wall Bumpers, and Floor Stops: Comply with BHMA A156.16 and Resilient Material Retention Test as described in this standard.
- D. Material: Base metal as indicated for each item by BHMA material and finish designation.
- E. Types:
 - 1. Wall Bumpers: Bumper, concave, wall stop.
- F. Installation:
 - 1. Non-Masonry Walls: Confirm adequate wall reinforcement has been installed to allow lasting installation of wall bumpers.
- G. Products:
 - 1. Wall Bumpers.

2.13 THRESHOLDS

- A. Manufacturers:
 - 1. National Guard Products, Inc: www.ngpinc.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
 - 1. Threshold Surface: Fluted horizontal grooves across full width.
- C. Grades: Thresholds: Comply with BHMA A156.21.
- D. Types: As applicable to project conditions. Provide barrier-free type at every location where specified.
- E. Products:
 - 1. 8425.

2.14 WEATHERSTRIPPING AND GASKETING

- A. Manufacturers:
 - 1. National Guard Products, Inc: www.ngpinc.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
 - 1. Weatherstripping Air Leakage Performance: Not exceeding 0.3 cfm/sq ft of door opening at 0.3 inches of water pressure differential for single doors, and 0.5 cfm/sq ft of door area at 0.3 inches of water pressure differential for double doors for gasketing other than smoke control, as tested according to ASTM E283/E283M; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
- C. Grades: Comply with BHMA A156.22.
- D. Products:
 - 1. Weatherstripping: See Door Hardware Schedule.
 - 2. Door Bottom Seals:
 - a. Door Sweeps: See Door Hardware Schedule.

2.15 ELECTRIFIED HARDWARE

- A. Manufacturers:
 - 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 - 2. dormakaba commercial, dormakaba Group: www.dormakaba.com/us-en/#sle.

3. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
1. Power Supply Units: Manufacturer's standard.
 - a. Enclosures: NEMA Type 1, with hinged cover and knockouts.
 - b. Power: 24 VAC, 10 Amp; field-selectable.
 - c. Emergency Release Terminals: Designed to release devices upon activation of fire alarm system.
 - d. Auxiliary contacts for remote signaling.
 - e. User-selectable time delay from 0 to 4 minutes.
 - f. Fire Alarm System Interface: Standard.
 - g. Output Distribution Board with indicator LEDs.
 - h. On/Off LED power indicator.
 2. Power Transfers: Manufacturer's standard.
 - a. Door Loops:
 - 1) Armored flex conduits 18 inches (450 mm) long.
 - 2) Capacity: Up to 1/4 inch (6.35 mm) diameter wire bundle.
 3. Wire Harnesses: Of sufficient length, with quick connectors.
 - a. Wire Harness End Connection to Power Supply or Junction Box: One end with bare leads.
- C. Products:
1. Power Supplies:
 - a. 8Q003.
 2. Power Transfers:
 - a. EPT-12C.
 3. Wire Harnesses:
 - a. BEST wire harnesses.

2.16 KEYS AND CORES

- A. Manufacturers:
1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 2. Substitutions: Not permitted.
- B. Properties: Complying with guidelines of BHMA A156.28.
1. Provide small format interchangeable core.
 2. Provide Standard keys and cores.
 3. Provide keying information in compliance with DHI (KSN) standards.
 4. Keying Schedule: Arrange for a keying meeting, with Architect, Owner and hardware supplier, and other involved parties to ensure locksets and locking hardware, are functionally correct and keying complies with project requirements.
 5. Keying: Master keyed.
 6. Include construction keying and control keying with removable core cylinders.
 7. Supply keys in following quantities:
 - a. Master Keys: 4 each.
 - b. Construction Master Keys: 6 each.
 - c. Construction Keys: 15 each.
 - d. Construction Control Keys: 2 each.
 - e. Control Keys if New System: 2 each.
 8. Provide key collection envelopes, receipt cards, and index cards in quantity suitable to manage number of keys.
 9. Deliver keys with identifying tags to Owner by security shipment direct from manufacturer.
 10. Permanent Keys and Cores: Stamped with applicable key marking for identification. Do not include actual key cuts within visual key control marks or codes. Stamp permanent keys "Do Not Duplicate."

11. Include installation of permanent cores and return construction cores to hardware supplier. Construction cores and keys to remain property of hardware supplier.

- C. Products:
1. Standard

2.17 KEY CABINETS

- A. Manufacturers:
1. Lund Equipment Company, Inc: www.lundkey.com/#sle.
 2. Telkee: www.telkee.com/#sle.
 3. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:.
1. Key Management System: For each keyed lock on project, provide one set of consecutively numbered duplicate key tags with hanging hole and snap catch.
 2. Security Key Tags: For each keyed lock on project, provide one set of matching key tags for permanent attachment to one key of each set.
 3. Provide key collection envelopes, receipt cards, and index cards in quantity suitable to manage number of keys.
 4. Mounting: Wall surface mounted.
 5. Capacity: Actual quantity of keys, plus 25 percent additional capacity.
 6. Key cabinet lock to facility's keying system.
- C. Finishes: Baked enamel, manufacturer's standard color.
- D. Material: Sheet steel.
- E. Products:
1. Lund
 2. Telkee:

2.18 FIRE DEPARTMENT LOCK-BOXES

- A. Manufacturers:
1. Knox Company; Knox-Box Rapid Entry System www.knoxbox.com/#sle.
 2. Substitutions: See Section 016000 - Product Requirements.
- B. Properties:
1. Heavy-duty, recessed, solid steel box with hinged door and interior gasket seal; single drill-resistant lock with dust covers and tamper alarm.
 2. Capacity: Holds 10 keys.
 3. Construction complying with UL 1037, UL 1610, and UL 437.
- C. Finishes: Manufacturer's standard coating.
1. Color: Manufacturer's standard dark bronze.
- D. Options: As applicable to each item specified.
- E. Products:
1. Knox

2.19 FINISHES

- A. Finishes: Identified in Hardware Sets.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.
- B. Correct all defects prior to proceeding with installation.
- C. Verify that electric power is available to power operated devices and of correct characteristics.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Install hardware using the manufacturer's fasteners provided. Drill and tap all screw holes located in metallic materials. Do not use "Riv-Nuts" or similar products.
- C. Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
- D. Install hardware for smoke and draft control doors in accordance with NFPA 105.
- E. Use templates provided by hardware item manufacturer.
- F. Do not install surface mounted items until application of finishes to substrate are fully completed.
- G. Wash down masonry walls and complete painting or staining of doors and frames.
- H. Complete finish flooring prior to installation of thresholds.
- I. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list; unless noted otherwise in Door Hardware Schedule or on drawings.
 - 1. For Steel Doors and Frames: Install in compliance with DHI (LOCS) recommendations.
 - 2. For Steel Door Frames: See Section 081213.
 - 3. For Aluminum-Framed Storefront Doors and Frames: See Section 084313.
 - 4. For Wood Doors: Install in compliance with DHI WDHS.3 recommendations.
 - 5. Flush Wood Doors: See Section 081416.
 - 6. Stile and Rail Wood Doors: See Section 081433.
 - 7. Mounting heights in compliance with ADA Standards:
 - a. Locksets: 40-5/16 inch (1024 mm).
 - b. Push Plates/Pull Bars: 42 inch (1067 mm).
 - c. Deadlocks (Deadbolts): 48 inch (1219 mm).
 - d. Exit Devices: 40-5/16 inch (1024 mm).
 - e. Door Viewer: 43 inch (1092 mm); standard height 60 inch (1524 mm).
- J. Set exterior door thresholds with full-width bead of elastomeric sealant at each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.
- K. Include in installation for existing doors and frames any necessary field modification and field preparation of doors and frames for new hardware. Provide necessary fillers, reinforcements, and fasteners for mounting new hardware and to cover existing door and frame preparations.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Section 014000 - Quality Requirements.

3.04 ADJUSTING

- A. Adjust work under provisions of Section 017000 - Execution and Closeout Requirements.
- B. Adjust hardware for smooth operation.
- C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.05 CLEANING

- A. Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.
- B. Clean adjacent surfaces soiled by hardware installation activities.
- C. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

3.06 PROTECTION

- A. Protect finished Work under provisions of Section 017000 - Execution and Closeout Requirements.
- B. Do not permit adjacent work to damage hardware or finish.

3.07 DOOR HARDWARE

Manufacturer List

| Code | Name |
|------|-------------------------------|
| AB | ABH Manufacturing Inc. |
| BE | Best Access Systems |
| BY | By Related Section |
| DM | Dorma Door Controls |
| NA | National Guard |
| PR | BEST Precision Exit Devices |
| SH | dormakaba Commercial Hardware |
| ST | BEST Hinges and Sliding |
| TR | Trimco |

Option List

| Code | Description |
|------------------|--|
| B4E-HEAVY-KP | Beveled 4 Edges - Kick Plates |
| BF | BF (Best SFIC) Keyway |
| CE-12EA | Easy Access Panel |
| CK | Construction Keyed (Sgl) |
| CMK | Construction Master Keyed (Sgl) |
| CSK | Counter Sinking Of Kick And Mop Plates |
| JAMB/BRKT/FILLER | Jamb Brkt Filler/Shim |
| MLR | Electrified Latch Retraction |
| X | Request to Exit Function |

Finish List

| Code | Description |
|-------|-----------------------|
| 26D | Satin Chrome |
| 626 | Satin Chromium Plated |
| 630 | Satin Stainless Steel |
| 689 | Aluminum Painted |
| AL | Aluminum |
| BLACK | Black |
| US32D | Stainless Steel, Dull |

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Hardware Sets

Set #01

Doors: C134

| | | | | |
|---|----------------------|--------------------------------|-------|----|
| 2 | Continuous Hinge | 661HD UL 84" CE-12EA | AL | ST |
| 1 | Exit Device | QED124 MLR X | 626 | SH |
| 1 | Exit Device | QED125 BF CK X | 626 | SH |
| 2 | Exit Trim | QET170 E BF CK | 626 | SH |
| 3 | Final Core | 1C-7 | 626 | BE |
| 2 | Concealed Closer | RTS Series | 689 | DM |
| 2 | Overhead Stop | 9000 Series JAMB/BRKT/FILLER | US32D | AB |
| 1 | Power Supply (QED) | 8Q00312 | | SH |
| 1 | Card Reader | BY SECURITY CONTRACTOR | | BY |
| 2 | Door Position Switch | BY SECURITY CONTRACTOR | | BY |
| 2 | Harness | WH-192P | | ST |
| 2 | Harness | WH-12P | | ST |
| 2 | Harness | WH-6E | | ST |
| 1 | Gasketing | BY ALUM. FRAME MANUFACTURER | | NA |
| 2 | Length Pile Astragal | 336 P | | NA |
| 2 | Door Sweep | 200 SA | | NA |
| 1 | Threshold | 8425 | AL | NA |

NOTE: DOOR NORMALLY CLOSED AND LOCKED.
PRESENTING VALID CREDENTIAL RETRACTS LATCH FOR INGRESS.
EMERGENCY KEY OVERRIDE.
X SWITCH IN PUSHBAR TO SHUNT ALARM.
EXIT DEVICE IS FAIL SECURE.
FREE EGRESS AT ALL TIMES.

Set #02

Doors: C125A

| | | | | |
|---|------------------|----------------------------|-------|----|
| 1 | Continuous Hinge | 661HD UL 83" | AL | ST |
| 1 | Exit Device | QED112 BF CK | 626 | SH |
| 1 | Exit Trim | QET170 E BF CK | 626 | SH |
| 1 | Concealed Closer | RTS Series | 689 | DM |
| 1 | Overhead Holder | 9012 A JAMB/BRKT/FILLER | US32D | AB |
| 1 | Gasketing | BY ALUM FRAME MANUFACTURER | | NA |
| 1 | Door Sweep | 200 SA | | NA |
| 1 | Threshold | 8425 | AL | NA |

Set #101

Doors: C125B

| | | | | |
|---|--------------------|----------------------------|-----|----|
| 6 | Butt Hinge | FBB179 4.5" x 4.5" NRP | 26D | ST |
| 1 | Exit Device | QED124 MLR X | 626 | SH |
| 1 | Exit Device | QED125 BF CK X | 626 | SH |
| 2 | Exit Trim | QET170 E BF CK | 626 | SH |
| 3 | Final Core | 1C-7 | 626 | BE |
| 2 | Closer | ITS 9613 | 689 | DM |
| 2 | Kick Plate | K0050 10" x 2" LDW B4E CSK | 630 | TR |
| 2 | Wall Bumper | 1270CV | 626 | TR |
| 2 | Power Transfer | EPT-12C | 630 | PR |
| 1 | Power Supply (QED) | 8Q00312 | | SH |

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| | | | | |
|---|----------------------|------------------------|--|----|
| 1 | Card Reader | BY SECURITY CONTRACTOR | | BY |
| 2 | Door Position Switch | BY SECURITY CONTRACTOR | | BY |
| 2 | Harness | WH-192P | | ST |
| 2 | Harness | WH-12P | | ST |
| 2 | Harness | WH-6E | | ST |
| 1 | Gasketing | 5050 B Head & Jambs | | NA |
| 2 | Length Pile Astragal | 336 P | | NA |

NOTE: DOOR NORMALLY CLOSED AND LOCKED.
PRESENTING VALID CREDENTIAL RETRACTS LATCH FOR INGRESS.
EMERGENCY KEY OVERRIDE.
X SWITCH IN PUSHBAR TO SHUNT ALARM.
EXIT DEVICE IS FAIL SECURE.
FREE EGRESS AT ALL TIMES.

Set #102
Doors: C127, C141

| | | | | |
|---|----------------------|----------------------------|-------|----|
| 8 | Butt Hinge | FBB168 4.5" x 4.5" NRP | 26D | ST |
| 1 | Automatic Flush Bolt | 3810 X 3810 | 626 | TR |
| 1 | Lockset | 9K3-7D15D STD | 626 | BE |
| 1 | Coordinator | 3094B1 | BLACK | TR |
| 2 | Door Closer | QDC120 | 689 | SH |
| 2 | Kick Plate | K0050 10" x 1" LDW B4E CSK | 630 | TR |
| 2 | Mounting Bracket | 3095/3096 AS REQ'D | BLACK | TR |
| 1 | Dust Proof Strike | 3910 | 626 | TR |
| 1 | Gasketing | 5050 B Head & Jambs | | NA |
| 1 | Astragal | 139 SP | | NA |

Set #103
Doors: C140A, C140B

| | | | | |
|---|-------------|----------------------------|-----|----|
| 3 | Butt Hinge | FBB179 4.5" x 4.5" NRP | 26D | ST |
| 1 | Exit Device | QED112 BF CK | 626 | SH |
| 1 | Exit Trim | QET160 E BF CMK | 626 | SH |
| 2 | Final Core | 1C-7 | 626 | BE |
| 1 | Closer | ITS 9613 HO | 689 | DM |
| 1 | Kick Plate | K0050 10" x 2" LDW B4E CSK | 630 | TR |
| 1 | Gasketing | 5050 B Head & Jambs | | NA |

Set #104
Doors: C133, C135A, C136A, C138A, C139

| | | | | |
|---|--|---------------------|-----|----|
| 4 | Butt Hinge | FBB179 4.5" x 4.5" | 26D | ST |
| 1 | Deadbolt | 8T3-7M STD | 626 | BE |
| | NOTE: Bolt to project into the bottom door leaf. | | | |
| 1 | Lockset | 9K3-7R15D STD | 626 | BE |
| 2 | Wall Bumper | 1270CV | 626 | TR |
| 1 | Gasketing | 5050 B Head & Jambs | | NA |

Set #105
Doors: C128, C129

| | | | | |
|---|------------|--------------------|-----|----|
| 3 | Butt Hinge | FBB179 4.5" x 4.5" | 26D | ST |
| 1 | Lockset | 9K3-7D15D STD | 626 | BE |

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| | | | | |
|---|-------------|----------------------------|-----|----|
| 1 | Closer | ITS 9613 | 689 | DM |
| 1 | Kick Plate | K0050 10" x 2" LDW B4E CSK | 630 | TR |
| 1 | Wall Bumper | 1270CV | 626 | TR |
| 1 | Gasketing | 5050 B Head & Jambs | | NA |

Set #106

Doors: C130, C131

| | | | | |
|---|-------------|----------------------------|-----|----|
| 3 | Butt Hinge | FBB179 4.5" x 4.5" | 26D | ST |
| 1 | Privacy Set | 9K3-0L15D | 626 | BE |
| 1 | Closer | ITS 9613 HO | 689 | DM |
| 1 | Kick Plate | K0050 10" x 2" LDW B4E CSK | 630 | TR |
| 1 | Wall Bumper | 1270CV | 626 | TR |
| 1 | Gasketing | 5050 B Head & Jambs | | NA |

Set #107

Doors: C126, C136B, C138B

| | | | | |
|---|-------------|----------------------------|-----|----|
| 3 | Butt Hinge | FBB179 4.5" x 4.5" | 26D | ST |
| 1 | Push Plate | 1001-3 | 630 | TR |
| 1 | Pull Plate | 1018-3B | 630 | TR |
| 1 | Closer | ITS 9613 HO | 689 | DM |
| 1 | Kick Plate | K0050 10" x 2" LDW B4E CSK | 630 | TR |
| 1 | Mop Plate | KM050 6" x 1" LDW B4E CSK | 630 | TR |
| 1 | Wall Bumper | 1270CV | 626 | TR |
| 1 | Gasketing | 5050 B Head & Jambs | | NA |

Set #108

Doors: C135B, C136C, C138C

| | | | | |
|---|--|---------------------|-----|----|
| 4 | Butt Hinge | FBB179 4.5" x 4.5" | 26D | ST |
| 1 | Deadbolt | 8T3-7M STD | 626 | BE |
| | NOTE: Bolt to project into the bottom door leaf. | | | |
| 1 | Lockset | 9K3-7G15D STD | 626 | BE |
| 2 | Wall Bumper | 1270CV | 626 | TR |
| 1 | Gasketing | 5050 B Head & Jambs | | NA |

Opening List

| Opening | Hdw Set |
|---------|---------|
| C126 | 107 |
| C127 | 102 |
| C128 | 105 |
| C129 | 105 |
| C130 | 106 |
| C131 | 106 |
| C133 | 104 |
| C134 | 01 |
| C139 | 104 |
| C141 | 102 |
| C125A | 02 |
| C125B | 101 |
| C135A | 104 |
| C135B | 108 |
| C136A | 104 |
| C136B | 107 |
| C136C | 108 |
| C138A | 104 |
| C138B | 107 |
| C138C | 108 |
| C140A | 103 |
| C140B | 103 |

END OF SECTION

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**SECTION 08 8000
GLAZING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glazing, including:
 - 1. Insulating glass units.
 - 2. Monolithic glass.
- B. Glazing accessories, including:
 - 1. Glazing compounds.

1.02 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
- C. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- E. ASTM C1036 - Standard Specification for Flat Glass.
- F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- H. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
- I. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings.
- J. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation.
- K. GANA (GM) - GANA Glazing Manual.
- L. GANA (SM) - GANA Sealant Manual.
- M. NFRC 100 - Procedure for Determining Fenestration Product U-factors.
- N. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
- O. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data on Insulating Glass Unit 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 12 by 12 inch in size, showing coloration and design of each type of glass specified.
 - E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- 1.04 QUALITY ASSURANCE
- A. Perform Work in accordance with GANA Glazing Manual and GANA Sealant Manual for glazing installation methods.
 - B. Installer Qualifications: Company specializing in performing the work of this Section with minimum three years documented experience.
 - C. Provide each type of glass, primary sealant, and gasket from a single manufacturer with not less than five years documented experience in the production of required materials.
 - D. Basis of Design: Specifications for certain glass products are based on specific glass types by the specified basis of design manufacturer. Glass types manufactured by other acceptable manufacturers are permitted, subject to compliance with all performance requirements; and provided that deviations in performance and coloration are minor, and do not detract substantially from the indicated design intent.
 - 1. Comply with requirements specified in Section 01 4000 and Section 01 6000.
- 1.05 DELIVERY, STORAGE, AND HANDLING
- A. Comply with manufacturer's instructions for shipping, handling, storing, and protection of glass and glazing materials. Exercise exceptional care to prevent edge damage to glass, and damage to coatings.
 - B. Where insulating glass units will be exposed to substantial altitude changes during shipping, comply with manufacturer's recommendations for venting and sealing.
- 1.06 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.
 - C. Install sealants only when ambient temperature conditions can be maintained at or above 40 degrees F during installation and 48 hours immediately following installation.
- 1.07 WARRANTY
- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
 - B. Manufacturer's Warranty:
 - 1. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- 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 applicable codes, and as specified on structural Drawings.
 - 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. Design glazing units to reliably perform and remain reliably engaged on all edges under all service and thermal stresses, including those associated with partial shading.
 - 5. Limit center of glass deflection to the lesser of 3/4 inch or L/100 (where L is short side dimension of glass unit), or flexure limit of glass, whichever is less, with full recovery of glazing materials.
 - 6. Assure and confirm compatibility of all materials in contact with each other.
- B. 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-Factor: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7.8 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7.8 computer program.
 - 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.02 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 - 2. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
 - 3. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
 - 4. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
 - 5. Impact Resistant Safety Glass: Complies with ANSI Z97.1 - Class B, or 16 CFR 1201 - Category I criteria.
 - 6. Thicknesses: As specified; provide greater thickness as required for exterior glazing wind load design.

2.03 INSULATING GLASS UNIT APPLICATIONS

- A. Acceptable Insulating Glass Unit Manufacturers:
 - 1. Fabricator certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. General - Combined Requirements: If a particular glass unit is indicated to comply with more than one type of requirement, such as color, safety characteristics, or other requirements, comply with all specified requirements for each type as scheduled on Drawings.

- C. Insulating Glass Units: Types as indicated on Drawings.
1. Basis of Design: As specified in this Section below.
 2. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 3. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 4. Warm-Edge Spacers: Low-conductivity thermoplastic with desiccant warm-edge technology design.
 - a. Spacer Width: As required for specified insulating glass units.
 - b. Spacer Height: Manufacturer's standard.
 - c. Acceptable Products:
 - 1) H.B. Fuller Construction Products Inc; Kodispace 4SG: www.hbfuller.com/#sle.
 - 2) Quanex IG Systems, Inc.; Super Spacer TriSeal: www.quanex.com/#sle.
 - 3) Technoform Glass Insulation; TGI-Spacer: www.glassinsulation.us/#sle.
 - 4) Viracon, Inc.; VTS Thermal Spacer: www.viracon.com/#sle.
 - 5) Substitutions: See Section 01 6000 - Product Requirements.
 5. Spacer Color: Black.
 6. Edge Seal:
 - a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone sealant as secondary seal applied around perimeter.
 - b. Color: Black.
 7. Purge interpane space with dry air, hermetically sealed.
 8. Breather Tubes: Provide tubes from air space for insulating glass units without inert type gas that have a change of altitude greater than 2500 feet between point of fabrication and point of installation to permit pressure equalization of air space.
 - a. Breather Tubes: Seal breather tubes upon installation in accordance with insulating glass fabricator's requirements.
 9. Space between lites filled with air.
 10. Total Thickness: 1 inch, unless otherwise indicated or specified.

D. Insulating Glass Units: Safety glazing.

1. Applications:
 - a. Glazed lites in exterior doors.
 - b. Glazed sidelights and panels next to doors.
 - c. Locations required by applicable federal, state, and local codes and regulations.
 - d. Other locations specified or indicated on Drawings.
2. Glass Type: Same as other vision glazing except use fully tempered float glass for both outboard and inboard lites.

2.04 BASIS OF DESIGN - INSULATING GLASS UNITS

A. Basis of Design - Insulating Glass Units: Vision glazing, with low-e coating.

1. Applications: Exterior insulating glass glazing unless otherwise indicated.
2. Glazing Method: Dry glazing method, gasket glazing, unless otherwise indicated or specified.
3. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
4. Basis of Design - Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.

5. Outboard Lite: Heat-strengthened float glass, 1/4 inch thick, minimum.
 - a. Low-E Coating: Vitro Architectural Glass (formerly PPG Glass) Solarban 70 glass on #2 surface.
 - b. Glass: Clear.
6. Inboard Lite: Heat-strengthened float glass, 1/4 inch thick.
 - a. Coating: No coating on inboard lite.
 - b. Glass: Clear.
7. Substitutions: See Section 01 6000 - Product Requirements.

2.05 MONOLITHIC GLAZING UNITS

- A. General - Combined Requirements: If a particular glass unit is indicated to comply with more than one type of requirement, such as color, safety characteristics, or other requirements, comply with all specified requirements for each type as scheduled on Drawings.
- B. Monolithic Interior Vision Glazing:
 1. Applications: Interior glazing unless otherwise indicated or specified.
 2. Glass Type: Fully tempered float glass.
 3. Tint: Clear.
 4. Thickness: 1/4 inch, nominal.
 5. Glazing Method: Dry glazing method, tape and gasket spline, unless otherwise indicated for interior frame type.

2.06 GLAZING COMPOUNDS

- A. General Requirements:
 1. Provide black exposed glazing accessory materials, unless specifically indicated otherwise.
 2. Provide materials of hardness as recommended by manufacturer for required application and condition of installation in each case. Provide only compounds which are known to be fully compatible with surfaces contacted, including glass products, seals, and glazing channel surfaces.
- B. Butyl Sealant: Single component; ASTM C920, Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color.
- C. 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; black color.

2.07 ACCESSORIES

- A. Setting Blocks: Silicone or EPDM, 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: Silicone or EPDM, 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 Gaskets and Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.
 1. Size gaskets as required by manufacturer of glazing channel frame to provide proper pressure and bite on glazing units.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that the minimum required face and edge clearances are being provided.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- D. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.02 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.
- D. Sealed Insulating Glass Units: Seal breather tubes immediately prior to glass unit installation with bead of silicone sealant according to sealed insulating glass unit manufacturers requirements; do not crimp, bend, or otherwise damage breather tubes.

3.03 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. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- F. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, and paint.

3.04 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; do not block weep paths.
- 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.

3.05 INSTALLATION - DRY GLAZING METHOD (TAPE AND GASKET SPLINE GLAZING)

- A. Application - Exterior Glazed: Set glazing infills from the exterior of the building.
- B. Cut glazing tape to length; install on glazing pane. Seal corners by butting tape and sealing junctions with butyl sealant.
- C. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners; do not block weep paths.
- D. Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
- E. Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
- F. Carefully trim protruding tape with knife.

3.06 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent 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.

3.07 PROTECTION

- A. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION

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**SECTION 09 2116
GYPSUM BOARD ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal stud framing, including:
 - 1. Suspended metal ceiling framing.
 - 2. Other specified framing system accessories.
- B. Acoustic insulation and accessories.
- C. Gypsum board products, including:
 - 1. Gypsum wallboard.
- D. Gypsum board system accessories, including:
 - 1. Joint treatments.

1.02 REFERENCE STANDARDS

- A. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data.
- B. AISI S220 - North American Standard for Cold-Formed Steel Framing - Nonstructural Members.
- C. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- E. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
- F. ASTM C1513 - Standard Specification for Steel Tapping Screws for Cold Formed Steel Framing Connections.
- G. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- H. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- I. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- J. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
- K. 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.
- L. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- M. ASTM C1047 - Standard Specification for Accessories For Gypsum Wallboard and Gypsum Veneer Base.

- N. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.
- O. ASTM C1396/C1396M - Standard Specification for Gypsum Board.
- P. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- Q. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements.
- R. GA-216 - Application and Finishing of Gypsum Panel Products.
- S. GA-600 - Fire Resistance Design Manual.
- T. ICC (IBC) - International Building Code.
- U. UL (FRD) - Fire Resistance Directory.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with mechanical and electrical work. Do not attach or support metal framing to ducts, pipes, conduit, or similar items.
 2. Coordinate installation of ceiling suspension system with installation of overhead structural systems to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling anchors in a manner that will develop their full strength and at spacing required to support ceiling.
 3. Coordinate gypsum board work with requirements of Section 07 8400 to maintain integrity of fire-rated and smoke-rated partitions required to comply with specified regulatory requirements.
 4. Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.
 2. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- C. Shop Drawings: Indicate special details associated with acoustic seals.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- B. Stud Framing: Products that do not comply with AISI S220 or ASTM C754 are not permitted.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- B. Store metal products to prevent corrosion, under cover and above grade.

- C. Handle gypsum boards to prevent damage to ends, edges, and surfaces.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures at not less than 40 degrees F for non-adhesive attachment of gypsum board, and not less than 50 degrees F for adhesive attachment.
- B. Maintain ambient temperatures at not less than 50 degrees F for a period 48 hours before gypsum board finishing, during installation, and after installation of board materials.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216 as applicable.
- B. Fire Rated Assemblies: Provide completed assemblies as specified on Drawings.
 - 1. ICC (IBC) Item Numbers: Comply with applicable requirements of ICC (IBC) for the particular assembly.
 - 2. Gypsum Association File Numbers: Comply with requirements of GA-600 for the particular assembly.
 - 3. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).
 - 4. Where any specified rated assembly requires the use of proprietary gypsum board system products, installation methods or procedures, comply with specified rated assembly requirements including requirements associated with assembly options which may be selected by Contractor.

2.02 METAL FRAMING MATERIALS

- A. General Material and Product Requirements: Comply with AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent; of size and properties necessary to comply with ASTM C754 for spacing indicated, required, or specified.
 - 1. Minimum Structural Grade:
 - a. Standard Framing Applications: ST33H, for partitions with vertical span up to 10 feet.
 - 2. Minimum Corrosion Protection:
 - a. Non-Corrosive (Standard) Environments: G40, or equivalent in accordance with AISI S220, unless otherwise specified.
- C. Acceptable Manufacturers:
 - 1. ClarkDietrich: www.clarkdietrich.com/#sle.
 - 2. Jaimes Industries: www.jaimesind.com/#sle.
 - 3. CEMCO; California Expanded Metal Company: www.cemcosteel.com.
 - 4. MarinoWARE: www.marinoware.com/#sle.
 - 5. Phillips Manufacturing Co.: www.phillipsmfg.com/#sle.
 - 6. R-stud: www.rstud.com/#sle.
 - 7. SCAFCO Corporation: www.scafco.com/#sle.
 - 8. Steel Construction Systems: www.steelconsystems.com/#sle.
 - 9. Substitutions: See Section 01 6000 - Product Requirements.

- D. Metal Framing - General: Provide framing materials complying with specified standards and tested assemblies, 25 gage unless specified, noted, scheduled, or detailed otherwise on Drawings.
 - 1. Use minimum 20 gage non-structural studs at door jambs, tile backing support, and other locations indicated on Drawings.
 - 2. Minimum Metal Thickness:
 - a. 25 Gauge: 0.0179 inch.
 - b. 20 Gauge Non-Structural: 0.0296 inch.
 - 3. Stud Spacing: As specified in PART 3 EXECUTION of this Section.
- E. Studs: "C" shaped with ribbed webs, and flanges with rolled edge stiffeners.
 - 1. Runners: U shaped, sized to match studs.
 - 2. Other Stud System Accessories: Manufacturer's standard clips, shoes, ties, reinforcements, fasteners, and other accessories as required for a complete stud framing system.
 - a. Stud Fasteners: Comply with ASTM C1513; size and length to suit connecting requirements.
 - 3. Ceiling Channels: C-shaped.
 - 4. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
- F. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and screwed to secondary deflection channel set inside but unattached to top track.
- G. Non-Structural Framing Accessories:
 - 1. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.

2.03 CEILING SUSPENSION SYSTEM COMPONENTS

- A. Direct Hung Grid Suspension System for Interior Ceilings: ASTM C635/C635M; direct-hung system composed of main runners and cross-furring runners that interlock; size hanger wires for three times imposed loads, as determined by ASTM E488/E488M; corrosive resistant materials.
 - 1. Acceptable Products:
 - a. USG Corporation; Drywall Suspension System: www.usg.com/#sle.
 - b. Substitutions: See Section 01 6000 - Product Requirements.

2.04 BOARD MATERIALS

- A. Acceptable Manufacturers - Gypsum-Based Board:
 - 1. American Gypsum Company: www.americangypsum.com/#sle.
 - 2. CertainTeed Corporation: www.certainteed.com/#sle.
 - 3. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 - 4. Gold Bond Building Products, LLC provided by National Gypsum Company: www.goldbondbuilding.com/#sle.
 - 5. PABCO Gypsum: www.pabcogypsum.com/#sle.
 - 6. USG Corporation: www.usg.com/#sle.
 - 7. Substitutions: See Section 01 6000 - Product Requirements.

- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Applications: Use for vertical surfaces and ceilings, unless otherwise indicated or specified.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold-resistant board is required whenever board is being installed before the building is enclosed and conditioned.
 3. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 4. Thickness: As indicated on Drawings.
- C. Backing Board For Wet Areas:
1. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 2. Glass-Mat-Faced Backing Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
 - a. Applications: Tiling applications.
 - b. Standard Type Thickness: 5/8 inch.
 - c. Acceptable Products:
 - 1) CertainTeed Corporation; GlasRoc Tile Backer: 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) USG Corporation; Durock Brand Glass-Mat Tile Backerboard: www.usg.com/#sle.
 - 5) Substitutions: See Section 01 6000 - Product Requirements.
- D. Water-Resistant Gypsum Board: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
1. Applications: Ceilings and vertical surfaces in "wet" areas but not behind thinset tile.
 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. Thickness: As indicated on Drawings.
 5. Acceptable Products:
 - a. American Gypsum Company; M-Bloc: www.americangypsum.com/#sle.
 - b. Georgia-Pacific Gypsum; ToughRock Mold-Guard Gypsum Board: www.gpgypsum.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.05 ACOUSTICAL ACCESSORIES

- A. Resilient Furring Channels: AISI S220 galvanized steel sheet, 25 gage thickness; 1/2 inch depth, for attachment to substrate through one leg only.
1. Acceptable Manufacturers:
 - a. ClarkDietrich; RC Deluxe Resilient Channel: www.clarkdietrich.com/#sle.
 - b. CEMCO; California Expanded Metal Company; RC1-XD: www.cemcosteel.com.
 - c. Phillips Manufacturing Co.; RC-1 Tru-25 Resilient Sound Channel: www.phillipsmfg.com/#sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.

- B. Acoustic Insulation - General: Use type of acoustical insulation to comply with indicated assembly requirements.
 - 1. Where any specified rated assembly requires the use of proprietary acoustical insulation products, installation methods or procedures, comply with specified rated assembly requirements including requirements associated with assembly options which may be selected by Contractor.
- C. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced.
 - 1. Thickness: Full thickness of indicated wall framing.
- D. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

2.06 INSTALLATION AND FINISHING ACCESSORIES

- A. Special Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
 - 1. Corner Beads: Low profile, for 90 degree outside corners.
 - 2. L-Trim with Tear-Away Strip: Sized to fit 5/8-inch thick gypsum wallboard.
 - 3. Control Joints: One-piece, v-grooved control joint with integral perforated flanges; removable tape to protect v-groove during finishing.
 - a. Applications: Locations specifically noted on Drawings; also located at internal corners, wall locations at re-entrant soffit corners, and ceiling locations at re-entrant soffit corners whether or not specifically noted on Drawings.
- B. Joint Materials: ASTM C475/C475M, and as recommended by gypsum board manufacturer for project conditions.
 - 1. Interior Gypsum Board Tape: 2 inch wide, creased paper tape for joints and corners.
 - 2. Joint Compound for Wet Locations: Chemical quick-setting type for first 2 coats, and vinyl type top coat specially formulated for finishing topping.
- C. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- D. 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

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this Section before commencing work of this Section.

3.02 PREPARATION

- A. Provide wall layout on floor surfaces for review by Architect before commencing stud wall framing.
 - 1. Layout walls in contiguous areas on each floor and in each building wing or section, as directed by Architect.
 - 2. Commencement of stud wall framing prior to receipt of approval of layout from Architect is assumed at Contractor's sole risk if wall layout is required to change for any reason.

3.03 FRAMING INSTALLATION

- A. Suspended Ceilings and Soffits:
1. Level ceiling and soffit systems to a tolerance of 1/600.
 2. Laterally brace entire suspension system.
 3. Space ceiling framing and furring members 16 inches on center, except as otherwise specified.
 4. Space ceiling framing and furring members at water-resistant gypsum board locations not to exceed 12 inches on center.
 5. Direct Hung Ceiling Suspension System Installation:
 - a. Attach perimeter wall track or angle where support system meets vertical surfaces.
 - b. Mechanically join support members to each other and cut to fit into wall track.
 - c. Space main runners at 48 inches on center and cross tees at 24 inch on center, except as otherwise specified above.
- B. Stud Framing: Space studs in accordance with applicable requirements of ASTM C754, unless otherwise specified below.
1. Stud Spacing: 16 inches on center, except as otherwise indicated or required by specified tested assemblies, framing design requirements, or unless otherwise permitted or restricted by governing standard for applicable wall finish system:
 - a. Standard Gypsum Board Finishes: Comply with applicable requirements of ASTM C840.
 - b. Tiling Finishes: Comply with requirements of installation method for tiling applications specified in Section 09 3000.
 2. Provide supplemental framing matching primary wall framing to support cut edges of gypsum boards not supported by primary vertical wall framing members.
 3. Extend partition framing to structure in all locations, unless otherwise indicated on Drawings.
 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.
 - a. At partitions supported by on-grade slabs, provide top slip joint to accommodate 1-1/2 inch vertical movement. Provide deflection tracks or firestop tracks at slip joints where specified, or detailed on Drawings.
 5. Isolate stud system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support free from axial loading. Install each steel framing and furring member so that fastening surfaces do not vary more than 1/8 inch from plane of faces of adjacent framing.
- C. Framing Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
1. Access Doors: Coordinate placement of openings for access doors and hatches with Architect before framing opening. Avoid placing openings at highly visible locations on wall and ceilings. Refer to Section 08 3100.
- D. Blocking: Install wood blocking for support of the following items; see Section 06 1000 for additional requirements:
1. Framed openings.
 2. Wall-mounted cabinets.
 3. Plumbing fixtures.
 4. Toilet partitions.

5. Toilet accessories.
6. Wall-mounted door hardware.
7. Similar items indicated on Drawings.

3.04 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustical Furring: Install resilient channels to framing at maximum 24 inches on center. Locate gypsum board joints only over resilient channel members.
 1. Install with open leg facing up.
 2. Do not screw through gypsum board and resilient channel to wall stud; use screws that are only long enough to engage gypsum board and resilient channel.
 3. Install minimum number of screws required by code through the gypsum board into resilient channels. Remove screws not needed.
- B. 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.
- C. Acoustic Sealant: Install as follows:
 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.

3.05 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
 1. Space fasteners in accordance with ASTM C840 and manufacturer's recommendations.
 2. Install interior wall and partition boards in accordance with requirements of referenced installation standards, except where fire or sound rating requires a particular direction; comply with the method stated in the tested assembly data.
 3. Locate exposed end-butt joints as far from center of walls and ceilings as possible, and stagger not less than 24 inches in alternate courses of board.
- B. Single-Layer Non-Rated Applications: 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.
 1. Limit annular space between gypsum wall board edges and electrical device boxes to maximum 1/8 inch, or as limited by applicable Code.
- D. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.
- E. Installation on Metal Framing: Use screws for attachment of gypsum board.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces as indicated on Drawings; if not specifically indicated, provide control joints as follows:
 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 and Special Trim: Install at locations shown on Drawings and in accordance with manufacturer's instructions.

3.07 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated or specified.
 - 2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 - 3. Level 1: Wall areas above finished ceilings, whether or not accessible in the completed construction.
- C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 - 2. Taping, filling, and sanding are not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
 - 3. Taping, filling, and sanding are not required at base layer of double-layer applications.

3.08 TOLERANCES

- A. Maximum Variation of Framing Location and Alignment in Plan and Elevation: 1/4 inch in any direction.
- B. Maximum Variation of Framing from True Plumbness and Flatness: 1/8 inch in 10 feet.
- C. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.09 PROTECTION

- A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION

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**SECTION 09 3000
TILING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tiling, including:
 - 1. Tile for floor applications.
 - 2. Tile for wall applications.
- B. Installation accessories, including:
 - 1. Non-ceramic trim.

1.02 REFERENCE STANDARDS

- A. ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium).
- B. ASTM C499 - Standard Test Method for Facial Dimensions and Thickness of Flat, Rectangular Ceramic Wall and Floor Tile.
- C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- D. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- E. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
- F. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation.

1.03 DEFINITIONS

- A. Module Size: Actual tile size, with minor facial dimension as measured by ASTM C499, plus joint width indicated.
- B. Facial Dimension: Actual tile size, with minor facial dimension as measured by ASTM C499.
- C. Large Format Tile: Any tile unit that maintains an edge of 15 inches or greater in any dimension.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate location of tiling movement joints on concrete floor substrates with locations of concrete floor expansion and control joints; align substrate joints and tiling system joints where required by specified reference standards.
- B. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this Section; require attendance by all affected installers.
 - 1. Convene under general provisions of Section 01 7000.
 - 2. Review installation procedures and coordination requirements.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Samples: Submit manufacturer's color boards consisting of actual tiles showing full range of colors, textures, and patterns available for each type and composition of tile specified.
 - 1. Include samples of specified accessories requiring color selection.
 - 2. Submit manufacturer's color samples of available grout consisting of actual sections of grout showing full range of colors available for each type of grout specified.
- D. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Company specializing in performing tile installation, with minimum of five years of documented experience.
- B. Provide materials obtained from only one manufacturer for each type and color of tile, and for each type of mortar, grout, adhesive, and sealant.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Comply with referenced standards and manufacturer's recommendations for protection and maintenance of environmental conditions during and after installation.
- B. Do not install solvent-based products in an unventilated environment.
- C. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting and grout materials.
 - 1. Maintain higher temperatures for proprietary mortars and grouts when recommended by manufacturer.
- D. Vent temporary heaters to the exterior to prevent damage to tile work due to carbon dioxide accumulation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Manufacturers and products specified on Drawings.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
 - a. Acceptability of substituted items may be determined solely on the basis of design, appearance or finish.

2.02 TRIM AND ACCESSORIES

- A. Metal Trim: Satin natural anodized extruded aluminum, style, configuration, and dimensions to suit application, for setting using tile mortar or adhesive.
 - 1. Applications:
 - a. Open edges of wall and floor tile.
 - b. Transition between floor finishes of different heights.
 - c. Floor to wall joints, where specified floor and wall tile do not have manufactured coved units.
 - d. Borders and other trim as indicated on Drawings.
 - 2. Acceptable Manufacturers:
 - a. Blanke Corporation: www.blankecorp.com/#sle.
 - b. Futura Industries Corp./Futura Transitions: www.futuratransitions.com.
 - c. Genesis APS International: www.genesis-aps.com/#sle.
 - d. LATICRETE International, Inc.: www.laticrete.com/#sle.
 - e. Schluter-Systems: www.schluter.com/#sle.
 - f. Substitutions: See Section 01 6000 - Product Requirements.

2.03 SETTING MATERIALS

- A. Setting Materials -General:
 - 1. Use only the types of mortar bed materials to set the types of tile for which the mortar is labeled.
- B. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.
 - 1. Applications: For floor applications in new construction; high-bond Portland cement mortar.
 - a. Acceptable Products:
 - 1) Custom Building Products; MegaLite Crack Prevention Mortar, ProLite Tile & Stone Mortar, or Complete Contact Fortified Mortar.
 - 2) LATICRETE International, Inc.; 255 MultiMax or Sure Set.
 - 3) Mapei Corporation; Ultralite or Ultracontact.
 - 4) Substitutions: See Section 01 6000 - Product Requirements.
 - 2. Applications: For floor applications in existing construction, renovation, and tenant improvements; rapid-setting, high-bond latex Portland cement mortar.
 - a. Acceptable Products:
 - 1) Custom Building Products; MegaLite RS Crack Prevention Mortar , ProLite RS Tile & Stone Mortar, or Complete Contact RS Fortified Mortar.
 - 2) LATICRETE International, Inc.; 255 MultiMax or Sure Set.
 - 3) Mapei Corporation; Ultralite or Ultracontact.
 - 4) Substitutions: See Section 01 6000 - Product Requirements.
 - 3. Applications: For wall applications; non-sagging, latex Portland cement mortar.
 - a. Acceptable Products:
 - 1) Custom Building Products; MegaLite or FlexBond Crack Prevention Mortar.
 - 2) LATICRETE International, Inc.; LATICRETE 254 Platinum.
 - 3) Mapei Corporation; Ultraflex 3.
 - 4) Substitutions: See Section 01 6000 - Product Requirements.

2.04 GROUTS

- A. Standard Grout: ANSI A118.6 standard 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. Acceptable Products:
 - a. Custom Building Products; Polyblend Non-Sanded Grout/Sanded Grout: www.custombuildingproducts.com.
 - b. LATICRETE International, Inc.; LATICRETE 1500 Sanded Grout/1600 Unsanded Grout: www.laticrete.com.
 - c. Mapei Corporation; Keracolor S/U: www.mapei.com
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.05 MAINTENANCE MATERIALS

- A. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
 - 1. Composition: Water-based colorless silicone.

2.06 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.
 - 2. Fluid or Trowel Applied Type:
 - a. Thickness: 20 mils, maximum.
 - 3. Acceptable Products:
 - a. LATICRETE International, Inc.; LATICRETE FRACTURE BAN SC: www.laticrete.com/#sle.
 - b. Merkrete, by Parex USA, Inc.; Merkrete Fracture Guard: www.merkrete.com/#sle.
 - c. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 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. Cementitious Subfloor Surfaces: Verify that substrates are ready for tiling installation by testing for moisture and alkalinity (pH).
 - 1. Test as Follows:
 - a. Alkalinity (pH): ASTM F710.
 - b. Internal Relative Humidity: ASTM F2170.
 - c. Moisture Vapor Emission: ASTM F1869.

2. Obtain instructions if test results are not within limits recommended by tiling material manufacturer and setting material manufacturer.

E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Protect surrounding work from damage.

B. Vacuum clean surfaces and damp clean.

C. Repair substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

3.03 INSTALLATION - GENERAL

A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) recommendations.

B. Blending: For tile exhibiting color or pattern variations within the ranges of accepted submittals, verify that tile has been blended in the packages so that tile units taken from one package show same range in colors or patterns as those taken from other packages. If not blended in the packages, blend tile in the field before installation.

C. Floor System Coverage: Where specified for individual setting methods, install floor tile units with 100 percent mortar coverage by complying with applicable special requirements for back buttering of tile units in referenced ANSI A108 specifications.

D. Install crack isolation membrane to comply with ANSI A118.10 and membrane manufacturer's written instructions for full floor coverage.

E. Movement Joints: Comply with TCNA (HB) Method EJ171F requirements for locations, spacing, and installation of applicable movement joints, whether or not specifically indicated or detailed on Drawings, and as follows:

1. Spacing - Interior: Maximum 24 feet on center in each direction.
2. Joint Width: Match adjacent grouted joint widths, unless TCNA EJ171 requires a specific joint width based on joint location or joint service conditions.
3. Apply sealant joint to junction of tile and dissimilar materials and junction of dissimilar planes, including but not limited to floor to wall joints, corners, and metal trim and non-ceramic accessory items.
4. Keep movement joints free of setting adhesive and grout.
5. Form internal angles and corners square, not grouted, with sealant joint.
6. Form external angles and corners square, not grouted, with sealant joint.
7. Apply specified sealant to joints.

F. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.

G. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly.

1. Where floor and wall tile are of same dimensional module, align floor and wall joints.

H. 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.

I. Install non-ceramic trim in accordance with manufacturer's instructions.

J. Sound tile after setting. Remove and replace hollow sounding units.

- K. Keep control and expansion joints free of mortar, grout, and adhesive.
- L. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- M. Grout tile joints, except where movement joints are indicated or specified.
- N. 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.
- O. Allow completed tiling assemblies to cure full 72 hours before allowing heavy foot or equipment traffic on final installations.
- P. Seal joints between tile work and other work with sealant specified in Section 07 9200.
- Q. Remove tiling installations that do not conform to specified requirements and tolerances, particularly lippage tolerances, and re-install in compliance with specified requirements.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, latex-Portland cement bond coat.
 - 1. Grout Type: Standard grout with grout sealer.
 - 2. Provide 100 percent coverage of setting mortar over tile back surfaces.
 - 3. Use crack isolation membrane under all tile meeting or exceeding definition of large format tile units in nominal face dimension, and also where specified.

3.05 INSTALLATION - WALL TILE

- A. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.
 - 1. Grout Type: Standard grout with grout sealer.

3.06 TOLERANCES

- A. Comply with applicable requirements of ANSI A108.2, unless otherwise specified in this Section.
- B. Flatness - Finished Tiling Surfaces:
 - 1. Ceramic Tile: 1/4 inch in 10 feet.
 - 2. Pressed Tile and Porcelain Tile: 1/4 inch in 10 feet.
- C. Lippage - Adjacent Tile Units:
 - 1. Wall Tile Installations - Severe Lighting: 1/32 inch; joint width 1/16 inch to less than 1/4 inch; all tile sizes.
 - 2. Glazed Tile and Mosaic Tile: 1/32 inch; joint width 1/16 inch to 1/8 inch; 1 x 1 inch to 6 x 6 inch tile size.
 - 3. Pressed Floor Tile and Porcelain Tile: 1/32 inch; joint width 1/16 inch to less than 1/4 inch; all tile sizes.
 - 4. Pressed Floor Tile and Porcelain Tile: 1/16 inch; joint width greater than 1/4 inch; all tile sizes.

3.07 CLEANING

- A. Clean tile and grout surfaces.

- B. Unglazed tile may be cleaned with sulfamic acid solutions only when permitted by the tile and grout manufacturer's printed instructions, but not sooner than 14 days after completion of installation. Protect metal surfaces, iron, and vitreous fixtures from effects of acid cleaning. Flush surfaces with clean water before and after acid cleaning.
- C. Leave finished installation clean and free of cracked, chipped, broken, un-bonded, or otherwise defective tile work.

3.08 PROTECTION

- A. Do not permit traffic over finished floor surface for minimum 7 days after installation.

END OF SECTION

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**SECTION 09 5100
ACOUSTICAL CEILINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Acoustical ceiling systems, including:
 - 1. Suspended metal grid ceiling system.
 - 2. Acoustical units.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the location of hangers with other work.
- B. Sequencing: Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
 - 1. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Samples: Submit two samples minimum 6 by 6 inch in size illustrating material and finish of acoustical units.
- D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: 80 sq ft of each type and size.

1.05 QUALITY ASSURANCE

- A. System Installer Qualifications: Company specializing in the installation of products specified in this Section with minimum three years documented experience.

1.06 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 20 to 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers - Acoustic Panels:
 - 1. Manufacturers and ceiling panel products specified on Drawings.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
 - a. Acceptability of substituted items may be determined solely on the basis of design, appearance or finish.
- B. Acceptable Manufacturers - Suspension Systems:
 - 1. Same as for acoustical units.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ACOUSTICAL CEILINGS

- A. Acoustical Units - General: ASTM E1264, Class A.

2.03 SUSPENSION SYSTEMS

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
 - 1. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
 - 2. Finish: Manufacturer's standard, unless otherwise specified for grid type and location.
- B. Exposed Suspension System: Hot-dipped galvanized steel grid with steel cap.
 - 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 - 2. Profile: Tee; 15/16 inch face width.
 - 3. Finish: Baked enamel.
 - 4. Color: White.

2.04 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: Minimum 12 gauge, 0.08 inch galvanized steel wire.
- C. Hold-Down Clips: Manufacturer's standard clips to suit application.
- D. Perimeter Trim Profiles: Same material and finish as grid.
 - 1. Size: As required for installation conditions.
 - 2. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
- E. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

- A. Install after major above-ceiling work is complete.

3.03 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M 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. Locate system on room axis according to reflected plan.
- D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
 - 2. Overlap and rivet corners.
- E. Suspension System: 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.
 - 1. Support all fixtures weighing less than 56 lb by at least two supplementary No. 12 gage hangers if required by applicable building code; hangers may be slack.
- I. Do not eccentrically load system or induce rotation of runners.

3.04 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. Lay directional patterned units with pattern parallel to shortest room axis, unless otherwise indicated or directed.
- D. Fit border trim neatly against abutting surfaces.
- E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

F. Cutting Acoustical Units:

1. Cut to fit irregular grid and perimeter edge trim.
2. Make field cut edges of same profile as factory edges; finish cut edges to match factory finished edges if cut edge is exposed to view.

G. Install hold-down clips on panels within 20 ft of an exterior door.

3.05 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

A. Clean surfaces.

B. Replace damaged or abraded components.

END OF SECTION

**SECTION 09 6500
RESILIENT FLOORING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient flooring , including:
 - 1. Resilient sheet flooring.
 - 2. Resilient tile flooring.
 - 3. Luxury vinyl tile and plank flooring.
- B. Flooring system accessories.

1.02 RELATED REQUIREMENTS

- A. Section 09 6513 - Resilient Wall Base: Resilient wall base and accessories.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Install resilient flooring and accessories after other finishing operations, including painting have been completed.

1.04 REFERENCE STANDARDS

- A. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- B. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- C. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

1.05 SUBMITTALS

- A. See Section 01 3000 - 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. Verification Samples: Submit two samples, minimum 12 x 12 inch in size illustrating color and pattern for each resilient flooring product specified.
- D. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.
- E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Flooring Material: 50 square feet of each type and color.
 - 3. Clearly identify each package.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store materials in manufacturer's original unopened containers, with brand names and production lot numbers clearly marked.
 - 1. 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 until ready for installation.
 - 1. Maintain temperature in storage area between 65 degrees F and 85 degrees F, or within lower and upper temperature and humidity limits required by flooring manufacturer, whichever is more restrictive.
- C. Store materials for not less than 48 hours prior to installation in area of installation at a minimum temperature of 65 degrees F to achieve temperature stability. Thereafter, maintain conditions above 65 degrees F and not exceeding 85 degrees F, or within lower and upper temperature and humidity limits required by flooring manufacturer, whichever is more restrictive. Maintain temperature and relative humidity at the same levels during installation and after installation.
 - 1. Protect roll materials from damage by storing on end.
 - 2. Do not double stack pallets.

1.08 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty: Provide integrated manufacturer's warranty, as follows:
 - 1. Flooring Materials: Minimum 2 years from date of Substantial Completion.
 - 2. Installation: Minimum 2 years from date of installation; warrant entire installation against loss of adhesion to substrates.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Manufacturers and products specified on Drawings.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
 - a. Acceptability of substituted items may be determined solely on the basis of design, appearance or finish.

2.02 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Adhesives: Waterproof; types recommended by flooring manufacturer for specified flooring products and indicated substrate conditions.

- C. Metal Edge Trim: Satin natural anodized extruded aluminum, style, configuration, and dimensions to suit application, for setting using adhesive.
 - 1. Applications:
 - a. Open edges of flooring.
 - b. Transition between floor finishes of different heights.
 - c. Thresholds at door openings.
 - d. Borders and other trim as indicated on Drawings.
 - 2. Acceptable Manufacturers:
 - a. Blanke Corporation: www.blankecorp.com/#sle.
 - b. Futura Industries Corp./Futura Transitions: www.futura.transitions.com.
 - c. Genesis APS International: www.genesis-aps.com/#sle.
 - d. LATICRETE International, Inc.: www.laticrete.com/#sle.
 - e. Schluter-Systems: www.schluter.com/#sle.
 - f. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 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. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test as Follows:
 - a. Alkalinity (pH): ASTM F710.
 - b. Internal Relative Humidity: ASTM F2170.
 - c. Moisture Vapor Emission: ASTM F1869.
 - 2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- C. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- C. Prohibit traffic until filler is fully cured.
- D. Clean substrate.

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.

- C. Adhesive-Applied Installation:
 - 1. Spread only enough adhesive to permit installation of materials before initial set.
 - 2. Fit joints and butt seams tightly.
 - 3. Set flooring in place, press with heavy roller to attain full adhesion.
 - D. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
 - E. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 - 1. Metal Strips: Attach to substrate before installation of flooring using stainless steel screws.
 - F. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- 3.04 INSTALLATION - SHEET FLOORING
- A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
 - B. Seams are prohibited in bathrooms, kitchens, toilet rooms, and custodial closets.
 - C. Cut sheet at seams in accordance with manufacturer's instructions.
 - D. Seal seams by heat welding where indicated or required by manufacturer for applicable flooring products.
 - E. Chemically bond seams using seam sealer where indicated or required by manufacturer for applicable flooring products.
- 3.05 INSTALLATION - TILE AND PLANK FLOORING
- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.
 - B. Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.
 - C. Install square tile to indicated pattern. Allow minimum 1/2 full size tile width at room or area perimeter.
 - D. Install plank tile with a random offset of at least 9 inches from adjacent rows.
- 3.06 CLEANING
- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
 - B. Clean in accordance with manufacturer's written instructions.
- 3.07 PROTECTION
- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION

**SECTION 09 6513
RESILIENT WALL BASE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient wall base.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing: Install resilient wall base and accessories after other finishing operations, including painting have been completed.

1.03 REFERENCE STANDARDS

- A. ASTM F1861 - Standard Specification for Resilient Wall Base.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

1.06 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. Deliver and store materials in manufacturer's original unopened containers, with brand names and production lot numbers clearly marked.
- C. Store all materials off of the floor in an acclimatized, weather-tight space until ready for installation. Maintain storage space within lower and upper temperature and humidity limits required by flooring manufacturer
- D. Store materials for not less than 48 hours prior to installation in area of installation at a minimum temperature of 65 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F and not exceeding 85 degrees F, unless otherwise restricted by flooring manufacturer. Maintain temperature and relative humidity at the same levels during installation, and after installation.
 - 1. Protect roll materials from damage by storing on end.
 - 2. Do not double stack pallets.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Manufacturers and products specified on Drawings.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
 - a. Acceptability of substituted items may be determined solely on the basis of design, appearance or finish.

2.02 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; Style B, Cove, unless otherwise indicated on Drawings.
 - 1. Height: 4 inch.
 - 2. Thickness: 0.125 inch.
 - 3. Length: Roll.
 - 4. Color: To be selected by Architect from manufacturer's full range.

2.03 ACCESSORIES

- A. Adhesives: Waterproof; types recommended by manufacturer for specified products and indicated substrate conditions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

3.02 PREPARATION

- A. Clean wall substrates.

3.03 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Install in longest lengths possible; maintain minimum dimension of 18 inches between joints.
- B. Miter internal corners. At external corners, 'V' cut back of base strip to 2/3 of its thickness and fold.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.

3.04 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

END OF SECTION

**SECTION 09 6813
TILE CARPETING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet tile, fully adhered.

1.02 REFERENCE STANDARDS

- A. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- B. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- C. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
- D. CRI 104 - Standard for Installation of Commercial Carpet.

1.03 SUBMITTALS

- A. See Section 01 3000 - 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. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- E. Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver carpeting materials in original mill protective wrapping, with mill register numbers and tags attached.
- B. Store inside, in well ventilated area, protected from weather, moisture, and soiling.

1.06 FIELD CONDITIONS

- A. Stage materials in area of installation for minimum period of 24 hours prior to installation.

- B. Maintain minimum 70 degrees F ambient temperature 24 hours prior to, during and 24 hours after installation.
- C. Ventilate installation area during installation and for 72 hours after installation.
- D. Do not commence with carpet installation until painting and finishing work is complete and ceilings and overhead work has been tested, approved, and completed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Manufacturers and products specified on Drawings.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
 - a. Acceptability of substituted items may be determined solely on the basis of design, appearance or finish.

2.02 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
- B. Metal Edge Trim: Satin natural anodized extruded aluminum, style, configuration, and dimensions to suit application, for setting using tile mortar or adhesive.
 - 1. Applications:
 - a. Open edges of tile carpeting.
 - b. Transition between floor finishes of different heights.
 - 2. Acceptable Manufacturers:
 - a. Blanke Corporation: www.blankecorp.com/#sle.
 - b. Futura Industries Corp./Futura Transitions: www.futuratransitions.com.
 - c. Genesis APS International: www.genesis-aps.com/#sle.
 - d. LATICRETE International, Inc.: www.laticrete.com/#sle.
 - e. Schluter-Systems: www.schluter.com/#sle.
 - f. Substitutions: See Section 01 6000 - Product Requirements.
- C. Resilient Wall Base: Specified in Section 09 6500.
- D. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.
- E. Miscellaneous Materials: Provide other items recommended by carpet manufacturer and installer for the indicated conditions of carpet use, and as required for complete installation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.

- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test as Follows:
 - a. Alkalinity (pH): ASTM F710.
 - b. Internal Relative Humidity: ASTM F2170.
 - c. Moisture Vapor Emission: ASTM F1869.
 - 2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.
- D. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.
- C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- D. Vacuum clean substrate.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions and CRI 104 (Commercial).
- 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 indicated pattern, with pile direction alternating to next unit, set parallel to building lines unless otherwise indicated on Drawings.
- F. Locate change of color or pattern between rooms under door centerline.
- G. Fully adhere carpet tile to substrate.
- H. Trim carpet tile neatly at walls and around interruptions.
- I. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 - 1. Metal Strips: Attach to substrate before installation of flooring using stainless steel screws.

3.04 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION

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**SECTION 09 7200
WALL COVERINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Wall covering.

1.02 REFERENCE STANDARDS

- A. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. See Section 01 3000 - 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, 18 by 18 inch in size illustrating color, finish, and texture.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- F. Maintenance Data: Submit data on cleaning, touch-up, and repair of covered surfaces.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra 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.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the type of work specified in this Section with minimum five years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages or containers clearly labeled to identify manufacturer, brand name, quality and grade, and fire hazard classification.
- B. Inspect roll materials at arrival on site, to verify acceptability.
- C. Protect packaged adhesive from temperature cycling and cold temperatures.
- D. Store materials in a well ventilated area protected from weather, moisture, soiling, and extreme temperatures and humidity. Maintain temperature in storage area above 40 degrees F.

- E. Protect packaged adhesive from temperature cycling and cold temperatures.
 - F. Do not store roll goods on end.
- 1.06 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 during installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Manufacturers and products specified on Drawings.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
 - a. Acceptability of substituted items may be determined solely on the basis of design, appearance or finish.

2.02 WALL COVERINGS

- A. General Requirements:
 - 1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
 - 2. Chemical and Stain Resistance: No visible staining or discoloration and no damage to surface texture when tested in accordance with ASTM D1308.
- B. Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.
- C. Termination Trim: Extruded plastic, clear; corner angle profile with 3/4 inch legs for termination of wall covering at outside corners.
- D. Termination Trim Accessories: Aluminum extrusions with integral mounting flanges as required for secure anchoring to substrates before application of wall coverings.
 - 1. Basis of Design Manufacturer:
 - a. Fry Reglet Corp.: www.fryreglet.com.
 - 1) Corner Trim: WCTOSC.
 - 2) Edge and Base Trim: WCTBT125-217.
 - b. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. Other Acceptable Manufacturers:
 - a. Gordon Interior Specialties, division of Gordon, Inc.: www.gordoninteriors.com.
 - b. MM Systems Corporation: www.mmsystemscorp.com.
 - c. Pittcon Industries: www.pittconindustries.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- E. Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.

- F. Substrate Primer and Sealer: Free of volatile organic compounds (VOC); wall covering manufacturer's recommended type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are 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.

3.02 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. Apply termination trim accessories in accordance with manufacturer's instructions; fasten through gypsum board into wall framing at maximum 24 inch on center.
- H. Vacuum clean surfaces free of loose particles.

3.03 INSTALLATION

- A. Apply adhesive and wall covering in accordance with manufacturer's instructions.
- B. Use wall covering in roll number sequence.
- C. Razor trim edges. 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. Horizontal seams are not acceptable.
- F. Do not seam within 2 inches of internal corners or within 6 inches of external corners.
- G. Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.
- H. Do not install wall covering more than 1/4 inch below top of resilient base.
- I. Cover spaces above and below windows, above doors, in pattern sequence from roll.

J. Install termination trim.

K. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.04 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.

3.05 PROTECTION

A. Do not permit construction activities at or near finished wall covering areas.

END OF SECTION

**SECTION 09 9113
EXTERIOR PAINTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.

1.02 DEFINITIONS

- A. Comply with ASTM D16 for interpretation of terms used in this section.
- B. Gloss Ratings: ASTM D523; on 60 and 85 degree gloss meters:
 - 1. MPI Gloss Level 1 (Flat): Not more than five units at 60 degrees and 10 units at 85 degrees.
 - 2. MPI Gloss Level 2 (Velvet): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees.
 - 3. MPI Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees.
 - 4. MPI Gloss Level 4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees.
 - 5. MPI Gloss Level 5 (Semi-Gloss): 35 to 70 units at 60 degrees.
 - 6. MPI Gloss Level 6 (Gloss): 70 to 85 units at 60 degrees.
 - 7. MPI Gloss Level 7 (High Gloss): More than 85 units at 60 degrees.

1.03 REFERENCE STANDARDS

- A. ASTM D523 - Standard Test Method for Specular Gloss.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
- C. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual.
- D. SSPC-SP 1 - Solvent Cleaning.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate painting and coating of facility services components and accessories with requirements specified in Divisions 21 through 28.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
 - 3. Manufacturer's application instructions.
- C. Samples: Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on aluminum sheet, 8 by 10 inch in size.

- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Paint and Finish Materials: 1 gallon of each color; from the same product run, store where directed.
 - 3. Label each container with color in addition to the manufacturer's label.
- 1.06 QUALITY ASSURANCE
- A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience.
 - B. Basis of Design: Specifications are based on paint types and systems by specified basis of design manufacturer. Paint types and systems manufactured by other acceptable manufacturers are permitted, subject to compliance with specified requirements; and provided that deviations in formulation, compatibility, and performance are minor, and do not detract substantially from the indicated design intent.
 - 1. Comply with requirements specified in Section 01 4000 and Section 01 6000.
- 1.07 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
 - B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
 - C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.
- 1.08 FIELD CONDITIONS
- A. Do not apply materials when surface and ambient temperatures are outside the paint product manufacturer's temperature ranges.
 - B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
 - C. Do not apply exterior paint and finishes during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
 - D. Minimum Application Temperatures for Latex Paints: 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- B. Basis of Design Manufacturer:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.

- C. Other Acceptable Manufacturers:
 - 1. Benjamin Moore & Co.: www.benjaminmoore.com.
 - 2. Diamond Vogel Paints: www.diamondvogel.com/#sle.
 - 3. PPG Paints: www.ppgpaints.com/#sle.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Acceptable Manufacturers - Primers and Sealers: Same manufacturer as top coats; no exceptions.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 3. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 4. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.
- B. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- C. Colors: As scheduled on Drawings.

2.03 PAINT SYSTEMS

- A. Exterior Surfaces to be Painted, Unless Otherwise Indicated: Including fiber cement siding and primed metal.
 - 1. Two top coats and one coat primer on all surfaces unless otherwise specified; omit field-applied primer on shop-primed metals.
 - 2. Top Coat(s): Exterior Latex; Fiber Cement.
 - a. Acceptable Product:
 - 1) Sherwin-Williams Loxon Self-Cleaning Acrylic Exterior, Satin.
 - 2) Substitutions: See Section 01 6000 - Product Requirements
 - 3. Top Coat(s): Exterior Light Industrial Coating, Water Based; Ferrous Metals.
 - a. Acceptable Products:
 - 1) Sherwin-Williams Pro Industrial DTM Acrylic, Semi-Gloss. (MPI #163)
 - 2) Sherwin-Williams Pro Industrial Multi-Surface Acrylic, Semi-Gloss.
 - 3) Substitutions: See Section 01 6000 - Product Requirements
 - 4. Primers: As recommended by top coat manufacturer for specific substrate.

2.04 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Test shop-applied primer for compatibility with subsequent cover materials.
- F. 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. Fiber Cement Siding: 12 percent.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Fiber Cement Siding: Remove dirt, dust and other foreign matter with a stiff fiber brush. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
- G. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.

3.03 PAINTING AND COATING - GENERAL

- A. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Exposed surfaces of steel lintels and ledge angles.
 - 2. Items specifically indicated on Drawings to receive paint finish.
- B. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.

2. Items indicated to receive other finishes.
3. Items indicated to remain unfinished.
4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
5. Non-metallic roofing and flashing.

3.04 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance.
- D. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply additional coats until complete hide is achieved.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

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**SECTION 09 9123
INTERIOR PAINTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.

1.02 DEFINITIONS

- A. Comply with ASTM D16 for interpretation of terms used in this section.
- B. Gloss Ratings: ASTM D523; on 60 and 85 degree gloss meters:
 - 1. MPI Gloss Level 1 (Flat): Not more than five units at 60 degrees and 10 units at 85 degrees.
 - 2. MPI Gloss Level 2 (Velvet): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees.
 - 3. MPI Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees.
 - 4. MPI Gloss Level 4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees.
 - 5. MPI Gloss Level 5 (Semi-Gloss): 35 to 70 units at 60 degrees.
 - 6. MPI Gloss Level 6 (Gloss): 70 to 85 units at 60 degrees.
 - 7. MPI Gloss Level 7 (High Gloss): More than 85 units at 60 degrees.

1.03 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials.
- D. ASTM D523 - Standard Test Method for Specular Gloss.
- E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual.
- F. SSPC-SP 1 - Solvent Cleaning.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate painting and coating of facility services components and accessories with requirements specified in Divisions 21 through 28.
- B. Sequencing: Apply paints and coatings after facility has been stabilized at designed ambient room temperatures, and before flooring products have been installed, to greatest extent possible.
 - 1. If not possible in certain and limited circumstances, comply with FIELD CONDITIONS requirements specified in the Section.

1.05 SUBMITTALS

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

- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. Cross-reference to specified paint system products to be used in project; include description of each system.
 - 3. Manufacturer's installation instructions.
- C. Samples: Submit two painted samples, illustrating selected colors for each color and system selected with specified coats cascaded. Submit on tempered hardboard, 8 by 10 inch in size.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Paint and Finish Materials: 1 gal of each color; from the same product run, store where directed.
 - 3. Label each container with color in addition to the manufacturer's label.

1.06 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience.
- B. Basis of Design: Specifications are based on paint types and systems by specified basis of design manufacturer. Paint types and systems manufactured by other acceptable manufacturers are permitted, subject to compliance with specified requirements; and provided that deviations in formulation, compatibility, and performance are minor, and do not detract substantially from the indicated design intent.
 - 1. Comply with requirements specified in Section 01 4000 and Section 01 6000.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F above the dew point, or to damp or wet surfaces.
- D. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 fc measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- B. Basis of Design Manufacturer:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- C. Other Acceptable Manufacturers:
 - 1. Benjamin Moore & Co.: www.benjaminmoore.com.
 - 2. Diamond Vogel Paints: www.diamondvogel.com/#sle.
 - 3. PPG Paints: www.ppgpaints.com/#sle.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Acceptable Manufacturers - Primer Sealers: Same manufacturer as top coats; no exceptions.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 3. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 4. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content:
 - 1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - b. Architectural coatings VOC limits of Colorado.
 - 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- D. Colors: As scheduled on Drawings.
 - 1. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling under which they are mounted.

2.03 PAINT SYSTEMS

- A. Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, wood, and shop primed steel.

1. Top Coat(s): Institutional Low Odor/VOC Interior Latex; Gypsum Board.
 - a. Acceptable Products:
 - 1) Sherwin-Williams ProMar 200 Zero VOC Interior Latex, Low Sheen.
 - 2) Sherwin-Williams ProMar 200 Zero VOC Interior Latex, Semi-Gloss.
 - 3) Substitutions: See Section 01 6000 - Product Requirements
 2. Primer: As recommended by top coat manufacturer for specific substrate.
- B. Medium Duty Applications: For surfaces subject to frequent contact by occupants, including metals and wood:
1. Metals: Include doors, door frames, railings, handrails, guardrails, and similar items.
 - a. Two top coats on shop primer, unless otherwise indicated.
 2. Wood: Include doors, door frames, casings, trim, and similar items.
 - a. Two top coats and one coat primer.
 3. Top Coat(s): High Performance Architectural Interior Latex; Metals.
 - a. Acceptable Product:
 - 1) Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, Semi-Gloss. (MPI #141)
 - 2) Substitutions: See Section 01 6000 - Product Requirements
 4. Top Coat(s): Interior Alkyd, Water Based; Wood.
 - a. Acceptable Product:
 - 1) Sherwin-Williams Emerald Urethane Trim Enamel, Semi-Gloss. (MPI #169)
 - 2) Substitutions: See Section 01 6000 - Product Requirements
 5. Primer: As recommended by top coat manufacturer for specific substrate.

2.04 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been adequately prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Test shop-applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
 1. Gypsum Wallboard: 12 percent.
 2. Interior Wood: 6 to 8 percent, measured in accordance with ASTM D4442.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- F. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- G. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

3.03 PAINTING AND COATING - GENERAL

- A. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Mechanical and Electrical:
 - a. In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. In finished areas, paint shop-primed items.
- B. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Floors, unless specifically indicated.
 - 6. Concealed pipes, ducts, and conduits.

3.04 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- D. Apply each coat to uniform appearance in thicknesses specified by manufacturer.

- E. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- F. Sand wood and metal surfaces lightly between coats to achieve required finish.
- G. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- H. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

SECTION 10 2113.13
METAL TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal toilet compartments.
- B. Urinal screens.

1.02 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- D. ICC A117.1 - Accessible and Usable Buildings and Facilities.
- E. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with placement of support framing and anchors in walls and ceilings.
 - 2. Coordinate location and installation of toilet accessories mounted on or in immediate proximity to toilet partitions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
- C. Product Data: Provide data on panel construction, hardware, and accessories.
- D. Samples: Submit manufacturer's full range of available colors, for selection.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. All American Metal Corp - AAMCO: www.allamericanmetal.com/#sle.
 - 2. ASI Accurate Partitions: www.asi-accuratepartitions.com/#sle.
 - 3. ASI Global Partitions: www.asi-globalpartitions.com/#sle.
 - 4. Bradley Corp.: www.bradleycorp.com.

5. General Partitions Mfg. Corp.: www.generalpartitions.com/#sle.
6. Hadrian: www.hadrian-inc.com/#sle.
7. Knickerbocker Partition Corp.: www.knickerbockerpartition.com.
8. Metpar Corp.: www.metpar.com.
9. Substitutions: Section 01 6000 - Product Requirements.

2.02 MATERIALS

- A. Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.

2.03 COMPONENTS

- A. Toilet Compartments: Powder coated steel, floor-mounted headrail-braced.
 1. Comply with NFPA 286, Class B, for finish surfaces of partition systems.
- B. Doors, Panels, and Pilasters: Sheet steel faces, pressure bonded to sound-deadening core, corners made with corner clips or mitered, welded, and ground smooth.
 1. Panel Faces: 22 gauge, 0.0299 inch.
 2. Door Faces: 22 gauge, 0.0299 inch.
 3. Pilaster Faces: 22 gauge, 0.0299 inch.
 4. Reinforcement: 12 gauge, 0.1046 inch.
 5. Internal Reinforcement: Provide in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
- C. Door and Panel Dimensions:
 1. Thickness: 1 inch.
 2. Door Width: 24 inch; 32 inch at ambulatory accessible stalls.
 3. Door Width for Handicapped Use: 36 inch, out-swinging.
 4. Height: 63-1/2 inches.
- D. Pilasters: 1-1/4 inch thick, of sizes required to suit compartment width and spacing.
- E. Urinal Screens: Wall mounted with continuous panel brackets.
 1. Minimum Size: 24 inches wide x 48 inches high, bottom edge positioned 12 inches above floor surface.

2.04 ACCESSORIES

- A. Pilaster Shoes: Formed ASTM A666 Type 304 stainless steel with No.4 finish, 3 inches high, concealing floor fastenings.
 1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
- B. Head Rails: Hollow anodized aluminum tube, 1 by 1-5/8 inches in size, with anti-grip strips and cast socket wall brackets.
- C. Brackets: Satin stainless steel.
- 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: Satin stainless steel:
 1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
 2. Nylon bearings.

3. Thumb turn or sliding door latch with exterior emergency access feature. Comply with ADA Standards at accessible compartment stalls.
4. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
5. Coat hook with rubber bumper; one per compartment, mounted on door.
6. Provide door pull for outswinging doors.
7. Accessible Toilet Compartment Doors: Self-closing with pull handle on both sides of door adjacent to latch in accordance with ICC A117.1.

2.05 FINISHING

- A. Powder-Coated Steel Compartments: Manufacturer's standard process; clean, degrease, and neutralize.
 1. Color: As selected by Architect from manufacturer's full range of available standards.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that field measurements are as indicated on Drawings.
- C. Verify correct spacing of and between plumbing fixtures.
- D. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 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. Adjust locations of brackets as required to eliminate conflict with wall tile edges and other transitions between dissimilar wall finish materials.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.
- E. Field touch-up of scratches or damaged enamel finish will not be permitted. Replace damaged or scratched materials with new materials.

3.03 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch.
- B. Maximum Variation From Plumb: 1/8 inch.

3.04 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

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**SECTION 10 2619
WALL PROTECTION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall protection components, including:
 - 1. Corner guards.

1.02 REFERENCE STANDARDS

- A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- B. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
- C. ASTM F476 - Standard Test Methods for Security of Swinging Door Assemblies.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
- C. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
 - 1. Submit two sections of corner guards, 12 inches long.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wall and door protection items in original, undamaged protective packaging. Label items to designate installation locations.
- B. 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.
- C. Store products in either horizontal or vertical position, in compliance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Babcock-Davis: www.babcockdavis.com/#sle.
 - 2. Construction Specialties, Inc.: www.c-sgroup.com/#sle.
 - 3. Inpro: www.inprocorp.com/#sle.
 - 4. Koroseal Interior Products: www.koroseal.com/#sle.
 - 5. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

- 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.

2.03 WALL PROTECTION COMPONENTS

- A. Corner Guards - Surface Mounted:
 - 1. Material: Type 430 stainless steel, No. 4 finish, 14 gauge, 0.0641 inch thick.
 - 2. Width of Wings: 2 inches.
 - 3. Corner: Square.
 - 4. Length: One piece.

2.04 ACCESSORIES

- A. Adhesives and Primers: As recommended by manufacturer.

2.05 SOURCE QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide wall and door protection systems of each type from a single source and manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as instructed by the manufacturer.
- B. 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.
- C. Start of installation constitutes acceptance of project conditions.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.
- B. Position corner guard 4 inches above finished floor to 60 inches high, unless otherwise indicated on Drawings.

3.03 TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch.
- B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

3.04 CLEANING

- A. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION

**SECTION 10 2813
TOILET AND UTILITY ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured accessories, including:
 - 1. Commercial toilet accessories.
 - 2. Utility room accessories.

1.02 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- B. ASTM C1036 - Standard Specification for Flat Glass.
- C. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- D. ASTM F446 - Standard Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area.
- E. ICC A117.1 - Accessible and Usable Buildings and Facilities.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate locations of accessories with other work to avoid interference, and to assure proper operation and servicing of accessory units.
 - 2. Coordinate location and installation of toilet accessories mounted on or in immediate proximity to toilet partitions.
 - 3. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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.

1.05 QUALITY ASSURANCE

- A. Provide accessories by the same manufacturer for each type of accessory unit, and for units exposed in the same areas, to ensure matching of finishes.
- B. Comply with ASTM F446 for grab bars and accessories, including, anchorage, test methods, and performance.

- C. Basis of Design: Specifications and Drawings are based on accessory types and model numbers by the specified basis of design manufacturer. Accessory types manufactured by other acceptable manufacturers are permitted, subject to compliance with specified requirements, and provided that deviations in dimensions and profile are minor, and do not detract substantially from the indicated design intent.
 - 1. Comply with requirements specified in Section 01 4000 and Section 01 6000.
- 1.06 DELIVERY, STORAGE, AND HANDLING
- A. Do not deliver accessories to site until rooms in which they are to be installed are ready to receive them.
 - B. Pack accessories individually in a manner to protect accessory and its finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design Manufacturer:
 - 1. Manufacturers and products as specified on Drawings.
 - 2. Substitutions: Section 01 6000 - Product Requirements.

2.02 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.
- C. Stainless Steel Sheet: ASTM A666, Type 304.
- D. Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.
- E. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.
- F. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.03 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.
- B. Back paint components where contact is made with building finishes to prevent electrolysis.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.

- D. Verify that field measurements are as indicated on Drawings.
- E. See Section 06 1000 and 09 2116, as applicable, for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.
- C. Before starting work notify Architect in writing of any conflicts detrimental to installation or operation of units.
- D. Verify with Architect exact locations of accessories.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated on Drawings.
- D. Use concealed fasteners wherever possible.
- E. Where exposed mounting devices and fasteners are necessary, provide such devices finished to match accessory; use security type fasteners for all exposed accessory mountings.
- F. Unless otherwise indicated, align accessory units with adjacent fixtures and other elements within the same area. Conform to ICC A117.1 for mounting structural strength, positions, and mounting heights.

3.04 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.
- B. Protect adjacent or adjoining finished surfaces and work from damage during installation of work of this Section.
- C. Protect exposed accessory finishes from damage until final acceptance of the Work.

3.05 CLEANING AND ADJUSTMENT

- A. Clean and polish all exposed surfaces after installation, and after removal of labels and protective coatings or coverings.
- B. Test and adjust accessories for proper and smooth operation.

END OF SECTION

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**SECTION 10 4400
FIRE PROTECTION SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire protection specialties, including:
 - 1. Fire extinguishers.
 - 2. Fire extinguisher cabinets.

- B. Accessories.

1.02 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide.
- B. NFPA 10 - Standard for Portable Fire Extinguishers.
- C. UL (DIR) - Online Certifications Directory.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features, extinguisher ratings and classifications, color and finish, anchorage details, and installation instructions.
- C. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.04 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com/#sle.
 - 2. Kidde, a unit of United Technologies Corp.: www.kidde.com.
 - 3. Larsen's Manufacturing Co.: www.larsensmfg.com.
 - 4. Nystrom, Inc.: www.nystrom.com.
 - 5. Potter-Roemer: www.potterroemer.com/#sle.
 - 6. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FIRE EXTINGUISHERS

- A. 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. Stored Pressure Operated: Deep Drawn.
 - 2. Class: A:B:C type.
 - 3. Size: 10 pound.
 - 4. Finish: Baked polyester powder coat red color.
 - 5. Temperature Range: -65 degrees F to 120 degrees F.

2.03 CABINETS

- A. Cabinet Configuration: Semi-recessed type, unless otherwise indicated or specified.
 - 1. Sized to accommodate scheduled items and accessories.
 - 2. Trimless type.
 - 3. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim and door stiles.
- B. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- C. Door Glazing: Tempered glass, clear, 1/8 inch thick, and set in resilient channel glazing gasket.
- D. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- E. Fabrication: Weld, fill, and grind components smooth.
- F. Finish of Cabinet Exterior Trim and Door: Baked enamel, color as selected.
- G. Finish of Cabinet Interior: White colored enamel.

2.04 ACCESSORIES

- A. Lettering: "FIRE EXTINGUISHER" decal, or vinyl self-adhering, prespaced black lettering in accordance with authorities having jurisdiction (AHJ).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Fire Extinguisher Cabinets: Install cabinets plumb and level in wall openings, maximum 30 inches from finished floor to inside bottom of cabinet.
- C. Secure rigidly in place.

D. Place extinguishers in cabinets.

END OF SECTION

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**SECTION 12 3600
COUNTERTOPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Countertops, including:
 - 1. Countertops for architectural wood casework.
- B. Accessory components, including:
 - 1. Wall-hung counters and vanity tops.

1.02 REFERENCE STANDARDS

- A. ISFA 2-01 - Classification and Standards for Solid Surfacing Material.
- B. NEMA LD 3 - High-Pressure Decorative Laminates.
- C. PS 1 - Structural Plywood.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizing and configuration of countertops with associated casework and adjacent construction.
 - 2. Coordinate sizing and locations of cutouts for plumbing fixtures with base cabinet configurations for proper alignments as indicated on Drawings.

1.04 SUBMITTALS

- A. See Section 01 3000 - 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. Specimen warranty.
- C. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other Sections.
 - 1. Include countertop seam/joint locations; approval of locations is required prior to fabrication.
- D. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.
- E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.
- F. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.05 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.

1.06 MOCK-UP

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Mock-Up: Full size mock-up of each specified countertop type, in conjunction with complete base unit.
 - 1. Locate where directed.
 - 2. Mock up may remain as part of the work.

1.07 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.

1.08 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

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. As specified in this Section for each countertop type and application.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
 - a. Acceptability of substituted items may be determined solely on the basis of design, appearance or finish.

2.02 COUNTERTOPS - GENERAL

- A. Quality Standard:
 - 1. Match quality standard for each casework type and finish as specified in Section 06 4100.

2.03 COUNTERTOP MATERIALS

- A. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
 - 1. Flat Sheet Thickness: 3/4 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.
 - 3. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - 4. Other Components Thickness: 1/2 inch, minimum.
 - 5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.
 - 6. Skirts: As indicated on Drawings.
 - 7. Fabricate in accordance with manufacturer's standard requirements.

2.04 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 and Joint Fillers: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined; color as selected by fabricator to blend with primary surface color to conceal appearance of joint.
- C. Joint Sealant: Mildew-resistant silicone sealant, clear color.

2.05 ACCESSORIES

- A. Grommets: Standard plastic grommets for cut-outs, in color to blend with adjacent surface.
- B. Countertop Support Brackets:
 - 1. Material: Tempered, fabricated steel brackets designed for surface or flush mounting as indicated on Drawings; sizes and configurations as indicated on Drawings.
 - 2. Acceptable Product:
 - a. Rakks/Rangine Corporation; EH-Series - Counter Support Brackets; www.rakks.com.
 - b. Substitutions: See Section 01 6000 - Product Requirements.

2.06 FABRICATION

- A. General: 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.
 - 3. Seams: Arrange seams symmetrically or in orderly locations, minimum 12 inches from edges of sink and similar cutouts.
 - 4. 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 walls with contact surfaces set in waterproof adhesive.
 - 2. Height: 4 inches, unless otherwise indicated.
- C. Solid Surfacing and Composite Countertops: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant and joint filler in accordance with manufacturer's recommendations and instructions.
- D. Wall-Mounted Countertops: Provide skirts, aprons, brackets, and braces as indicated on Drawings, finished to match.

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 INSTALLATION

- A. Install countertop support brackets securely to wall blocking; see Section 06 1000 for additional requirements.
- B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- C. Securely attach countertop brackets to structural framing as detailed on Drawings; securely attach countertops to brackets using concealed fasteners.
- D. Install grommets in countertops where indicated on Drawings; coordinate precise locations with Owner or Architect prior to drilling holes for grommets.
- E. Seal joint between back/end splashes and vertical surfaces.

3.04 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.

3.05 CLEANING

- A. Clean countertop surfaces thoroughly.

3.06 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 22 0500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 22.
- B. Motors shall comply with Division 23: Section 23 05 14 - "Common Motor Requirements".

1.2 SUMMARY

- A. Section includes:
 - 1. General administrative and procedural requirements, as well as the following basic plumbing materials and methods.
 - 2. Submittals.
 - 3. Coordination drawings.
 - 4. Record documents.
 - 5. Operation and Maintenance manuals.
 - 6. Rough-ins.
 - 7. Plumbing installations.
 - 8. Cutting and patching.
 - 9. Concrete equipment base construction requirements.
 - 10. Equipment nameplate data requirement.
 - 11. Labeling and identifying mechanical systems and equipment is specified in Section 15075 "Identification for Plumbing Piping and Equipment."
 - 12. Non-shrink grout for equipment installations.
 - 13. Field-fabricated metal and wood equipment supports.
 - 14. Installation requirements common to equipment specification Sections.
 - 15. Plumbing demolition.
 - 16. Touchup painting and finishing.

1.3 ACRONYMS

- A. The following list of abbreviations are utilized within the specifications and are provided as a reference:
 - ADA - American Disability Act
 - AGA - American Gas Association
 - ANSI - American National Standards Institute
 - ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
 - ASME - American Society of Mechanical Engineers
 - ASTM - American Society for Testing and Materials
 - AWS - American Welding Society
 - AWWA - American Water Works Association
 - BOCA - Building Officials and Code Administrators
 - CS - Commercial Standard
 - IBR - Institute of Boiler and Radiator Manufacturers
 - IEEE - Institute of Electrical and Electronics Engineers

| | | |
|--------|---|--|
| IMC | - | International Mechanical Code |
| IPC | - | International Plumbing Code |
| MSSP | - | Manufacturers Standards Society of the Valve and Fittings Industry |
| NEC | - | National Electrical Code |
| NEMA | - | National Electrical Manufacturers Association |
| NFPA | - | National Fire Protection Association |
| OSHA | - | Occupational Safety and Health Administration |
| SMACNA | - | Sheet Metal and Air Conditioning Contractors National Association |
| TEMA | - | Tubular Exchanger Manufacturers Association |
| UL | - | Underwriters' Laboratories |

1.4 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term product includes the terms material, equipment, system, and terms of similar intent.
1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes proposed by Contractor in products, materials, equipment, and methods of construction required by the Contract Documents.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named, or a product is accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.
- D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
- E. Extended Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.5 SYSTEM DESCRIPTION

- A. Design Requirements: Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required.
1. Furnish and install all items as may be required at no additional cost to fit the

- work to the conditions encountered.
2. Arrange piping, equipment and other work generally as shown on the contract drawings, providing proper clearances and access.
 3. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawing submittal for approval in accordance with Submittals specified below.
 4. Subject to the provisions of Division 01, Architect may make reasonable changes in location of equipment piping and ductwork up to the time of rough-in or fabrication.

1.6 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the contract and Division 01 Specification Sections.
- B. Shop Drawings and Product Data:
 1. Clearly identify all submittals:
 - a. Indicate intended application, location, etc.
 - b. Each submittal shall indicate the associated specification section, and paragraphs. Do not combine product data and shop drawing submittals from different spec sections into a single submittal package, even though they may be the same distributor, vendor or part of a single material order.
 - c. Clearly indicate the exact type, model number, size and special features of the proposed item.
 - d. Include catalog spec sheets to completely describe proposed equipment.
 - e. Factory order forms only showing the required capacities are not acceptable.
 - f. Identify all options furnished to meet specifications.
 - g. If product is within system supplying fixture intended to dispense potable water for human consumption, including drinking and cooling, submittals shall indicate that product is "lead free", containing not more than a weighted average of 0.25% lead with respect to the wetted surfaces.
 - h. Solder and flux for soldered joints in potable water piping shall be "lead free", containing not more than 0.2% lead.
 - i. The Architect shall not select equipment ratings and/or options. Submittals not properly marked shall be returned without review.
- C. Product Substitutions: Comply with requirements of Division 01.
- D. Comparable Products Submission:
 1. Document each request for a proposed comparable product with supporting data substantiating compliance of proposed product with Basis-of-Design product.
 2. Use the attached "Comparable Product Submittal Form" in addition to the requirements specified herein.
 3. Comparable products will not be reviewed without completion of the attached form.
- E. Coordination Drawings
 1. Prepare coordination drawings to a scale of 1/4" = 1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where

sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

- a. Indicate the proposed locations of piping, valving, ductwork, equipment, and materials. Include the following:
- b. Planned piping layout, including valve and specialty locations and valve stem movement.
- c. Planned piping systems layout, including valves and accessories.
- d. Clearances for installing and maintaining insulation.
- e. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
- f. Equipment connections and support details.
- g. Exterior wall and foundation penetrations.
- h. Fire-rated wall and floor penetrations.
- i. Sizes and location of required concrete pads and bases.
- j. Access doors.
- k. Clearances at electrical components in accordance with the National Electric Code.
- l. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- m. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. Show all wall mounted access doors for plumbing devices.
- n. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, cable trays, sprinklers, access doors and other ceiling mounted items.
- o. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, cable trays, sprinklers, access doors and other ceiling mounted items.
- p. Coordination drawings shall at a minimum include coordination with Division, 21, Division 23 and Division 26 installers. Include fire protection piping, domestic water piping (cold water, hot water and hot water re-circulation), natural gas piping sanitary piping, sanitary vent piping, closed loop supply and return piping, ductwork, flexible duct, ceiling mounted air devices, lights, ceiling and building structural members (floor slabs, beams, joists, etc.). Coordination drawings shall be provided at a minimum for:
 - 1) First Floor Corridor. Provide floor plans and at least two sections.
 - 2) Commercial kitchen piping layout. Provide floor plans and at least two sections.
 - 3) All Mechanical Rooms. Provide floor plans and at least two sections for each.
 - 4) Garage piping layout. Provide floor plans and at least two elevations. Indicate piping inverts of all piping crossing drive aisle.

F. Closeout Submittals:

1. Record Drawings: Prepare record documents in accordance with the requirements in the Division 01 specifications. In addition to the requirements specified in Division 01, indicate the following installed conditions:
 - a. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with

- valve tag chart. Refer to Section 22 05 53 - "Identification for Plumbing Piping and Equipment". Indicate actual inverts and horizontal locations of underground piping.
 - b. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - c. Approved substitutions, Contract Modifications, Responses to Contractor's Request for Information, and actual equipment and materials installed.
 - d. Record the locations and invert elevations of underground installations.
 - 2. Operation and Maintenance Data: Prepare operation and maintenance data in accordance with Division 01 specifications. In addition to the requirements specified in Division 01, include the following information for equipment items:
 - a. List of systems and equipment requiring service manuals.
 - b. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - c. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - d. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - e. Servicing instructions and lubrication charts and schedules.
 - f. Systems and Equipment test reports.
 - 3. Commissioning Report
- G. Color Selection: Color of finishes shall be as selected by the Architect. Submit colors of factory finished equipment for acceptance prior to ordering.
- H. Products and Materials:
 - 1. Submit complete descriptive data for all materials as follows:
 - a. Material specifications.
 - b. Data sheets.
 - c. Samples.
 - d. Capacity ratings.
 - e. Performance curves.
 - f. Operating characteristics.
 - g. Catalog cuts.
 - h. Dimensional drawings.
 - i. Wiring diagrams.
 - j. Lead Free, for potable water service.
 - k. Installation instruction.
 - l. Any other information necessary to indicate compliance with contract documents.
 - 2. Edit submittal data specifically for application to this project.
 - 3. Submit actual operating conditions and characteristics for all equipment.
 - 4. Catalogs or catalog cuts are not acceptable unless the particular item and all relative data has been marked in such a manner as to be clearly defined.
 - 5. Color of finishes shall be as selected by the Architect. Submit colors of factory finished equipment for acceptance prior to ordering.

6. No plumbing item shall be fabricated, purchased, delivered to the site or installed, until reviewed by the Architect.
 - a. After the proposed materials have been approved, no substitution will be permitted except where approved by the Architect.
7. Provide shop drawing and product data submittals as indicated under individual specification sections.
8. Provide any other equipment requested by the Architect.

1.7 QUALITY ASSURANCE

- A. Underwriter's Laboratory (UL) Requirements: All equipment containing electrical components and provided under Division 22 shall bear the Underwriter's Laboratory (UL) label, as a complete packaged system.
 1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a listed label at the installer's expense.
 - a. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.
 - b. Provide services of a UL recognized, independent Electrical Testing Laboratory (ETL) to provide field inspection and testing. Provide and ETL Label on all such equipment.
- B. Fire Safe Materials: Unless otherwise indicated, materials shall conform to UL, National Fire Protection Agency (NFPA) or American Society for Testing and Materials (ASTM) standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Division 01 specifications.
 1. Deliver, store, and handle products according to manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
 2. Schedule delivery to minimize long-term storage at Project Site and to prevent overcrowding of construction spaces.
 3. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 4. Deliver products to Project Site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 5. Inspect products upon delivery to ensure compliance with Contract Documents and to ensure that products are undamaged and properly protected.
 6. Store products in manner that will facilitate inspection and measurement.
 7. Store materials in a manner that will not endanger project structure.
 8. Store products subject to damage by elements above ground, under cover in a weather tight enclosure, with ventilation adequate to prevent condensation.
 9. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather protection requirements for storage.

1.9 PROJECT CONDITIONS

- A. Existing Conditions: Prior to preparing the bid, visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and all other matters, which can affect the work. No additional compensation will be made for

failure to determine the conditions under which the work will be performed.

B. Outages

1. All plumbing outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon with the Owner.
2. Unless otherwise specified, outages of any services in adjacent buildings required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled with the Owner at least fourteen days (14) days in advance. All such outages shall be coordinated with the owner in writing.
The owner reserves the right to partially occupy the building. Provide all necessary bypasses, isolation and other means and methods to limit the amount of time the building is without services.
3. The bid price shall include the cost of all premium time required for outages and other work which interferes with the normal use of the building.
4. The operation of valves or switches required to achieve an outage shall be accomplished by the Contractor in the Owner's presence. Unauthorized operation of valves, power switches, or other control devices shall not be permitted.

1.10 SEQUENCING

- A. Coordinate plumbing equipment installation with other building components.
- B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for plumbing installations.
- C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
- E. Coordinate connection of electrical services.
- F. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- G. Coordinate requirements for access panels and doors where plumbing items requiring access are concealed behind finished surfaces.
- H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1.11 PRODUCT WARRANTIES

- A. Comply with all requirements contained in the Division 01 Specifications and all requirements contained herein and other sections of Division 22.
- B. Warranties specified in other Sections shall be in addition to, and run concurrent with,

other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

- C. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
 - 1. Manufacturer's Standard Form: Modified to include project-specific information and properly executed.
 - 2. Refer to Divisions 02 thru 48 Sections for specific content requirements and particular requirements for submitting special warranties.
- D. Submittal Time: Comply with requirements in the Division 01 Specifications.

1.12 DISCREPANCIES

- A. Comply with the requirements set forth in the Division 01 specifications and contained herein.
- B. Where discrepancies occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quantity or higher cost shall be included in the contract price. The Architect shall decide on the item and manner in which the work shall be provided, based on the design intent of the documents.

1.13 ELECTRONIC CAD DOCUMENTS

- A. Requests for electronic CAD documents will be accommodated to the contractors and installers upon their completion of Given and Associates Electronic Document Release of Liability Form and payment for time and expense for document preparation.
 - 1. Given and Associates document preparation fee is as follows:
 - a. Two hundred and fifty dollars (\$250.00) for the first five (5) drawings.
 - b. Fifty dollars (\$50.00) for each drawing thereafter.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

- A. General Product Requirements: Provide products that comply with Contract Documents that are undamaged and new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for complete installation and intended use and effect.
 - 2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Where products are accompanied by the term as selected, Architect will make selection.
 - 4. Where products are accompanied by the term match sample, sample to be matched is Architect's.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. General Compliance Requirements: Compliance requirements for individual products, as indicated in Contract Documents, are multiple in nature and may include generic descriptions, performance requirements, compliance with reference standards,

conformance with graphic details and other similar forms and methods of indicating requirements, all of which must be complied with.

- C. Procedures for Selecting Products: Contractor's options for selecting products are limited by Contract Document requirements, and are not controlled by industry traditions or procedures experienced by Contractor on previous construction projects.
- D. Products specified by Reference Standards, Codes and Regulations: Select from among products, which can be shown to comply with referenced documents.
- E. Products specified by Naming Products and Manufacturers: Select from among products listed.
- F. Products specified by Naming One Manufacturer's Product as the Basis-of-Design with Reference to Other Manufacturers: Select either the specified Basis-of-Design product or an approved comparable product by one of the other named manufacturers.
 - 1. Comply with provisions in Comparable Products Article to obtain approval for use of a comparable product by one of the named manufacturers.
- G. Products specified by Naming One Manufacturer's Product and Indicating Option of Selecting Comparable Products by stating or Approved Equivalent or similar language: Select either the specified product or an approved comparable product.
 - 1. Comply with provisions in Comparable Products Article to obtain approval for use of a comparable product by one of the named or un-named manufacturers.
- H. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and, matches Architect's sample. Architect's decision will be final on whether proposed product matches satisfactorily.
- I. Visual Selection Specification: Where Specifications include the phrase as selected from manufacturer's standard colors, patterns, textures or similar phrase, select a product that complies with other specified requirements. Architect will select color, pattern, and texture.
 - 1. Standard Range: Where Specifications include the phrase standard range of colors, patterns, textures or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that does not include premium items.
 - 2. Full Range: Where Specifications include the phrase full range of colors, patterns, textures or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Where Basis-of-Design products are specified by name, submit the following, in addition to other required submittals, to obtain approval of a comparable product by one of the named manufacturers:
 - 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work. Use the attached Comparable Products Submittal Form in addition to

- requirements listed herein.
2. Detailed comparison of significant qualities of proposed product with the Basis-of-Design product in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, serviceability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.

2.3 GROUT

- A. Comply with requirements in the Division 03 Specifications and contained herein.
- B. Non-shrink, Nonmetallic Grout: ASTM C 1107, Grade B, "Packaged Dry, Hydraulic-Cement Grout (Non-shrink)", 2001.
 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi (34.50MPa), 28-day compressive strength.
 3. Packaging: Premixed and factory-packaged.

2.4 ACCESS DOORS AND PANELS

- A. Comply with the requirements set forth in the Division 08 Specifications and contained herein.
- B. Provide manufactured steel door assemblies consisting of:
 1. Hinged door.
 2. Flush screwdriver camlocks and frame.
- C. Doors shall be Milcor Metal Access doors. Provide key locks where indicated.
- D. Design shall be provided for the following installations:
 1. Masonry or Dry Wall: Style M.
 2. Hard Finish Plaster: Style AP.
 3. Fire rated dry wall ceilings: Style CFRAD, 1 hour combustible floor ceiling system, 1 hour non-combustible floor ceiling system, 3 hour non-combustible floor ceiling system.
 4. Suspended ceilings: Style CT.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Interface With Site Utility Companies:
 1. Contact UTILITY prior to any excavation or underground work.
 2. Contact local utility companies (gas, water, sewer, etc.) immediately upon award of contract. Do not install related equipment until fully coordinated with appropriate utilities.
 3. Provide all construction schedules, dates of requested services, outage windows,

- equipment locations, etc. necessary for utility work.
4. Gas Utility:
 - a. Coordinate additional gas load for previous buildings with utility company if connecting to an existing meter. Provide all necessary upgrades including but not limited to larger gas meter, pressure reducing valve, etc. per new calculated meter load.
 - b. Furnish and install all incoming concrete pads, sleeves, connections, etc.
 5. Water and Sewer Utilities:
 - a. Coordinate flow, usage and pressure requirements with local water and sewer authorities as necessary to obtain services.

3.2 INSTALLATION

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
 1. Coordinate mechanical systems, equipment, and materials installation with other building components.
 2. Verify all dimensions by field measurements.
 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 5. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 6. Where systems, materials and equipment are intended for overhead installation, and where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 7. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
 10. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
 11. Install access panel or doors where units or valves are concealed behind finished surfaces. Access panels and doors are specified in Division 08 and herein.
 12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- B. Rough-In
 1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
 2. Refer to equipment specifications in Divisions 02 through 26 for rough-in

requirements.

C. Housekeeping and Equipment Pads

1. Comply with the requirements in the Division 03 Specifications and contained herein.
2. Construct pads of dimensions indicated, but not less than 4 inches (100 mm) larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi (20.70MPa), 28-day compressive strength concrete and reinforcement bars.

D. Erection of Metal Supports and Anchorage

1. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
2. Field Welding: Comply with AWS D1.1, "Structural Welding Code -Steel", 2001.

E. Erection of Wood Supports and Anchorage

1. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.
2. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

F. Grouting

1. Install nonmetallic non-shrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.
2. Clean surfaces that will come into contact with grout.
3. Provide forms for placement of grout, as required.
4. Avoid air entrapment when placing grout.
5. Place grout to completely fill equipment bases.
6. Place grout on concrete bases to provide a smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout according to manufacturer's printed instructions.

G. Lintels

1. Lintels shall be provided for openings in masonry, brick, concrete, etc. walls to accommodate work of this division.
 - a. Lintels shall be provided under this division when not being provided under other divisions. Lintels shall be approved by the Architect.

H. Water Heaters:

1. Installation of water heaters, expansion tanks and all other pressure vessels shall be made in compliance with all state of Colorado requirements.

3.3 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with the Division 01 Specifications.

In addition to the requirements specified in Division 01, the following requirements apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of plumbing equipment and materials required to:
1. Uncover Work to provide for installation of ill-timed Work.
 2. Remove and replace defective Work.
 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 4. Remove samples of installed Work as specified for testing.
 5. Install equipment and materials in existing structures.
 6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.
- C. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- E. Patch finished surfaces and building components using new materials specified for the original installation and using experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 PAINTING AND FINISHING

- A. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- B. Do not paint manufacturer's labels or tags.

3.5 CONSTRUCTION

- A. Cutting, Welding, Burning
 1. If required, before commencing any cutting, welding, burning, brazing (pipe sweating), obtain a hot work permit from Environmental Health and Safety.
 2. If required, the hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

3.6 PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.
- B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.7 EXCAVATION AND BACKFILLING

A. General

1. Perform all necessary excavation, for installation of work under Division 22, in accordance with Division 31.

3.8 CLEANING

- A. Clean surfaces prior to application of insulation, adhesives, coating, and paint.
- B. Provide factory applied finish where specified.
- C. Protect all finishes, and restore all finishes to their original condition if damaged as a result of work under Division 22.
- D. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces.
- E. General: General cleaning during construction is required by the General Conditions and included in Section Temporary Facilities.
- F. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
- G. Remove all plumbing clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.9 PROTECTION

- A. Protect work, material and equipment from weather and construction operations before and after installation.
- B. Properly store and handle all materials and equipment.
- C. Cover temporary openings in piping, ductwork and equipment to prevent the entrance of water, dirt, debris, and other foreign matter.

3.10 LUBRICATION

- A. All bearings, motors and all equipment requiring lubrication shall be provided with accessible fittings.
- B. Before turning over the equipment to the Owner, provide the following:
 1. Fully lubricate each item of equipment.
 2. Provide 1 year's supply of lubricant for each type of lubricant.
 3. Provide complete written lubricating instructions, together with diagram locating the points requiring lubrication.
- C. Motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal extended grease fittings and drain plugs.

3.11 ELECTRICAL WORK

- A. It is the intent to provide a complete and operational system. The work between Division 22 and 26 is complementary and is meant to produce a single and operating system. Contractor shall make its own determination as to the distribution of responsibility among the various trades.
- B. All electrical work performed under Division 22 shall be provided in accordance with Division 26.

3.12 PROVISIONS FOR ACCESS

- A. Furnish and install adequate access to all plumbing components. The following list shall be used as a guide only:
 - 1. Plumbing equipment.
 - 2. Valves.
 - 3. Cleanouts.
 - 4. Traps.
- B. Access shall be adequate as determined by the Architect.
- C. Refer to contract drawings where panels have been specifically located.
- D. Provide additional panels for adequate access as indicated in paragraph A above.
- E. Where access is by means of liftout ceiling tiles or panels mark each panel using small color-coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.13 OPERATION OF EQUIPMENT

- A. Clean all systems and equipment prior to initial operation for testing and balancing.
- B. Do not operate equipment unless all proper safety devices or controls are operational.
- C. Provide all maintenance and service for equipment, which is operated during construction.
- D. Where specified and otherwise required, provide the services of a manufacturer's factory trained service organization to start the equipment.
- E. Do not use mechanical systems for temporary services during construction unless authorized in writing by the Architect.
 - 1. Where such authorization is granted, temporary use of equipment shall not limit or otherwise affect warranties or guarantees of the work.
- F. Upon completion of work, clean and restore all equipment to new conditions and replace all filters.

3.14 DEMONSTRATION

- A. Demonstrate operation and maintenance of equipment and systems to Owner's personnel a minimum two (2) weeks prior to date of final inspection.
 - 1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
 - 2. Training period shall be performed within 1 - two week period.
- B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.
- C. Demonstrate the following:
 - 1. Start up.
 - 2. Operation.
 - 3. Control.
 - 4. Adjustment.
 - 5. Trouble shooting.
 - 6. Servicing.
 - 7. Maintenance.
 - 8. Shutdown.
- D. Provide instruction to the operating personnel per Division 01 Training Requirements.
 - 1. Time of instruction shall be designated by the Owner.
 - 2. This instruction shall be in addition to instructional requirements of specific equipment specified elsewhere in Division 22.
 - 3. Record all training sessions. Provide the owner with three (3) copies of the recordings in digital versatile disk (DVD) format.

3.15 WALL AND FLOOR PENETRATION

- A. All penetrations of partitions, walls and floors by ducts, piping or conduit under Division 22 shall be sealed and caulked. Provide U.L. listed fire stopping systems at penetrations through fire rated walls.

3.16 EQUIPMENT PROVIDED UNDER ANOTHER DIVISION AND BY OTHERS

- A. Make all system connections required to equipment furnished and installed under another division and by others.
- B. It shall be the responsibility of the Contractor to coordinate all necessary data from the equipment supplied under other Divisions.

3.17 AS-BUILT DRAWINGS

Provide separate as-built drawings and record documents of all fire protection systems as required hereinbefore in this section.

3.18 PROJECT PUNCH OUT

- A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a

list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/ Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement will be made by deducting the Architect/Engineer fee from the Contractor's final payment.

COMPARABLE PRODUCT SUBMITTAL FORM

Table of Compliance (Sample)
Shop Drawing and Product Data Submittal

The Contractor shall prepare a Table of Compliance Form similar in format to the sample shown below to facilitate and expedite the Shop Drawing and Product Data Review. Failure to comply with this requirement will be basis for rejecting the Submittal.

The Table of Compliance Form will list and compare the performance parameters as the submitted equipment to that listed on equipment schedule and specifications as basis of design. All non-compliance items (differences) must be explained in full, indicating their impact, if any, on maintainability, durability, energy use, operating costs, code compliance and environmental considerations.

(Sample)
TABLE OF COMPLIANCE

EQUIPMENT: _____ SPEC. SECTION: _____

| BASIS OF DESIGN SAMPLE ITEMS | DRAWINGS | SUBMITTED | EXPLANATION |
|--|----------|-----------|-------------|
| Flow (Cfm Or Gpm) | | | |
| Ext. Static Press. | | | |
| Head (Ft.) | | | |
| Electrical Requirements | | | |
| Cooling Capacity | | | |
| Heating Capacity | | | |
| Discharge Air Temp. | | | |
| Filter Type & Eff. | | | |
| Equipment Eff. (Eer) | | | |
| Sound Data | | | |
| Weights | | | |
| Etc. | | | |
| Specifications: | | | |
| A. Quality assurance compliance (ARI) | | | |
| (ASHRAE) | | | |
| (AMCA) | | | |
| (UL) | | | |
| B. Specifications: List each and every specification paragraph | | | |
| C. Etc. | | | |
| Other: | | | |

END OF SECTION

SECTION 22 0503

PIPES AND TUBES 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, and all sections of Division 22.

1.2 SUMMARY

- A. Section includes:

1. Domestic water piping, within 5 feet of building.
2. Sanitary sewer piping, within 5 feet of building.
3. Air conditioning condensate, equipment drains, and over flows.
4. Unions and flanges.
5. Natural gas piping.
6. Piping Specialties and Accessories.
7. Limited Pipe Fittings.

- B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 26 05 26 - "Grounding and Bonding for Electrical Systems": for grounding connections to piping systems.
2. Section 22 05 00 - "Common Work Results for Plumbing."
3. Section 22 05 29 - "Hangers and Supports for Plumbing Piping and Equipment": Product requirements for hangers and supports for placement by this section.
4. Section 22 05 48 - "Vibration and Seismic Controls for Plumbing Piping and Equipment": Product requirements for vibration isolation for placement by this section.
5. Section 22 05 53 - "Identification for Plumbing Piping and Equipment."
6. Section 22 07 00 - "Plumbing Insulation": Product requirements for piping insulation for placement by this section.
7. Section 22 05 16 - "Expansion Fittings and Loops for Plumbing Piping."
8. Section 22 25 01 - "Plumbing Piping System Cleaning and Treatment."
9. Section 22 40 00 - "Plumbing Fixtures": Product requirements for equipment requiring water and sanitary connections.
10. Section 22 31 00 - "Domestic Water Softeners."
11. Section 22 05 93 - "Testing, Adjusting, and Balancing for Plumbing."

1.3 DEFINITIONS

- A. Gas Distribution Piping: Piping which conveys gas from the point of delivery to the points of usage.
- B. Point of Delivery is the outlet of the service meter assembly, or the outlet of the service regular (service shutoff valve when no meter is provided).
- C. Domestic Water Systems: A system conveying domestic potable or non-potable water, such as Cold Water, Hot Water, Hot Water circulating, etc.

D. Gravity Drainage Systems: A system of gravity fed effluent conveying storm water, sanitary, etc.

E. Lead Free:

1. The pipes, pipe fittings, plumbing fittings or fixtures in plumbing systems that are intended to dispense potable water for human consumption, including drinking and cooking, shall be "lead free", containing not more than a weighted average of 0.25% lead with respect to the wetted surfaces.
2. Solder and flux for soldered joints in potable water piping shall be "lead free", containing not more than 0.2% lead free.

1.4 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

A. ANSI (American National Standards Institute)

1. ANSI B16.39, "Malleable Iron Threaded Pipe Unions," January, 1999.
2. ANSI/ASME B1.20.1, "Pipe Threads, General Purpose (Inch)," R2006.
3. ANSI/ASME B16.3, "Malleable Iron Threaded Fittings," 2006.
4. ANSI/ASME B16.5, "Pipe Flanges and Flanged Fittings," January, 2003.
5. ANSI/ASME B16.21, "Non-metallic Flat Gaskets for Pipe Flanges," January, 1992.
6. ANSI/ASME B16.22, "Wrought Copper and Copper Alloy Solder Joint Pressure Fittings," 2001.
7. ANSI/ASME B16.29, "Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings (DWV)," February, 2002.
8. ANSI/API 600, "Bolted Bonnet Steel Gate Valves for Petroleum and Natural Gas Industries," 2006.
9. ANSI/AWS B2.1, "Standard Specification for Welding Procedure and Performance Qualification," January, 2000.
10. ANSI/AWS D10.12, "Guide for Welding Mild Steel Pipe," January, 2000.
11. ANSI/AWWA C104, "American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water," 2003.
12. ANSI/AWWA C110, "American National Standard for Ductile-Iron and Gray-Iron Fittings, 3in. Through 48in., for Water and Other Liquids," 2003.
13. ANSI/AWWA C111, "Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings," 2007.
14. ANSI/AWWA C151, "American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water," August, 2002.
15. ANSI/AWWA C153, "American National Standard for Ductile-Iron Compact Fittings, 3in. Through 24in., and 54in. Through 64in., for Water Service," 2006.

B. ASME (American Society of Mechanical Engineers)

1. ASME A112.1.2, "Air Gaps in Plumbing Systems," 2004.
2. ASME A112.14.1, "Back Water Valves," January, 1990.
3. ASME A112.21.2M, "Roof Drains," 1983.
4. ASME A112.36.2M, "Clean-outs," January, 1991.
5. ASME B16.1, "Cast Iron Pipe Flanges and Flanged Fittings," 2005.
6. ASME B16.4, "Cast Iron Threaded Fittings," 2006.
7. ASME B16.5, "Pipe Flanges and Flanged Fittings," 2003.
8. ASME B16.20, "Metallic Gaskets for Pipe Flanges- Ring-Joint, Spiral-Wound, and Jacketed," 2007.
9. ASME B16.21, "Nonmetallic Flat Gaskets for Pipe Flanges," 2005.
10. ASME B16.24, "Cast Copper Alloy Pipe Flanges and Flanged Fittings," 2006.

11. ASME B18.2.1, "Square and Hex Bolts and Screw- Inch Series," January, 1996.
12. ASME B18.10, "Track Bolts and Nuts," 2006.
13. ASME B31.1, "Power Piping," 2007.
14. ASME B31.9, "Building Services Piping," 2004.
15. ASME B40.1, "Gauges- Pressure Indicating Dial Type- Elastic Element," September, 1991.
16. ASTM/ASME B16.22, "Wrought Copper and Copper Alloy Solder Joint Pressure Fittings," 2001.
17. ANSI/ASME B1.20.1, "Pipe Threads, General Purpose (Inch)," 2006.
18. ANSI/ASME B16.3, "Malleable Iron Threaded Fittings," 1998.
19. ANSI/ASME B16.5, "Pipe Flanges and Flanged Fittings," 2003.
20. ANSI/ASME B16.18, "Cast Copper Alloy Solder Joint Pressure Fittings," 1994.
21. ANSI/ASME B16.22, "Wrought Copper and Copper Alloy Solder Joint Pressure Fittings," 2001.
22. ASME B16.25, "Butt-Welding Ends," January, 2007.
23. ANSI/ASME B16.29, "Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings (DWV)," October, 2007.
24. ANSI/AWA C606, "Grooved and Soldered Joints," 2006.

C. ASSE (American Society of Sanitary Engineers)

1. ASSE 1001, "Hose Connection Vacuum Breakers," 2008.
2. ASSE 1010, "Water Hammer Arresters," 2004.
3. ASSE 1013, "Reduced Pressure Principle Backflow Preventors," 2005.
4. ASSE 1015, "Double Check Backflow Prevention Assembly," 2005.
5. ASSE 1019, "Vacuum Breaker Wall Hydrants, Frost Resistant Automatic Draining Type," 2004.

D. ASTM (American Society for Testing and Materials)

1. ASTM A36, "Standard Specification for Carbon Structural Steel," March, 2001.
2. ASTM A47, "Standard Specification for Ferritic Malleable Iron Castings," 2004.
3. ASTM A53, "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless," 2007.
4. ASTM A74, "Standard Specification for Cast Iron Soil Pipe and Fittings," 2009.
5. ASTM A126, "Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings," 2004.
6. ASTM A167, "Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip," 2004.
7. ASTM A182, "Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service," 2008.
8. ASTM A183, "Standard Specification for Carbon Steel Track Bolts and Nuts," 2003.
9. ASTM A193, "Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service," 2008.
10. ASTM A194, "Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both," 2008.
11. ASTM A216, "Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service," 2007.
12. ASTM A234, "Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High-Temperature Service," 2007.
13. ASTM A276, "Standard Specification for Stainless Steel Bars and Shapes," 2008.
14. ASTM A278, "Standard Specification for Gray Iron Castings for Pressure Containing Parts," 2006.
15. ASTM A351, "Standard Specification for Stainless Steel Bars and Shapes," 2006.

16. ASTM A536, "Standard Specification for Ductile Iron Castings," 2004.
17. ASTM A564, "Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes," 2004.
18. ASTM A582, "Standard Specification for Free-Machining Stainless Steel Bars," 2005.
19. ASTM A780, "Standard Practice for Repair of Damaged and Un-coated Areas of Hot-Dip Galvanized Coatings," 2006.
20. ASTM B16, "Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines," 2005.
21. ASTM B32, "Standard Specification for Soldered Metal," 2008.
22. ASTM B62, "Standard Specification for Composition Bronze or Ounce Metal Castings," March 2002.
23. ASTM B88, "Standard Specification for Seamless Copper Water Tubes," March, 2002.
24. ASTM B124, "Standard Specification for Copper and Copper Alloy Forging Rod, Bar and Shapes," 2008.
25. ASTM B148, "Standard Specification for Aluminum-Bronze Sand Castings," 2003.
26. ASTM B306, "Standard Specification for Copper Drainage Tube (DWV)," March, 2002.
27. ASTM B584, "Standard Specification for Copper Alloy Sand Castings for General Applications," 2008.
28. ASTM C33, "Standard Specification for Concrete Aggregates," 2007.
29. ASTM C150, "Standard Specification for Portland Cement," 2007.
30. ASTM C1107, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrinking)," 2007.
31. ASTM C1540, "Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
32. ASTM D2321, "Standard Practice for Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications," 2005.
33. ASTM D635, "Standard Test Method for Rate of Burning and/or Extent and Time of Burning Plastics in a Horizontal Position," 2006.
34. ASTM D2464, "Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings," 2006.
35. ASTM D2564, "Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems," 2004.
36. ASTM D2665, "Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings," 2008.
37. ASTM D2729, "Standard Specification for Poly (Vinyl Chloride) PVC) Sewer Pipe and Fittings," 2003.
38. ASTM D2846, "Standard Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Hot- and Cold-Water Distribution Systems," 2006.
39. ASTM D3138, Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly Vinyl Chloride (PVC) Non-Pressure Piping Components," October, 2004.
40. ASTM E1, "Standard Specification for ASTM Thermometers," 2007.
41. ASTM F402, "Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners used for Joining Thermoplastic Pipes and Fittings," 2005.
42. ASTM F493, "Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings".
43. ASTM F656, "Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Pipe and Fittings".
44. ASTM F844, "Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use," 2007.
45. ASTM F2618, "Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Fittings for Chemical Waste Drainage Systems".

- E. AWS (American Welding Society)
 - 1. AWS D1.1, "Structural Welding Code- Steel," 2008.
 - 2. ANSI/AWS B2.1, "Standard Specification for Welding Procedure and Performance Qualification," 2006.
 - 3. ANSI/AWS D10.12, "Guide for Welding Mild Steel Pipe," January, 2000.

- F. AWWA (American Water Works Association)
 - 1. AWWA C600, "Standards for Insulation of Ductile-Iron Water Mains and their Appurtenances," 2005.
 - 2. AWWA C700, "Standard for Cold-Water Meters- Displacement Type, Bronze Main Case," January, 2003.
 - 3. AWWA C702, "Cold-Water Meters- Compound Type," January, 2001.
 - 4. ANSI/AWWA C104, "American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water," 2004.
 - 5. ANSI/AWWA C110, "American National Standard for Ductile-Iron and Gray-Iron Fittings, 3in. Through 48in., for Water and Other Liquids," December, 2003.
 - 6. ANSI/AWWA C111, "Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings," 2007.
 - 7. ANSI/AWWA C151, "American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water," August, 2002.
 - 8. ANSI/AWWA C153, "American National Standard for Ductile-Iron Compact Fittings, 3in. Through 24in., and 54in. Through 64in, for Water Service," January, 2000.
 - 9. ANSI/AWWA C606, "Grooved and Shouldered Joints," 1997.

- G. CISPI (Cast Iron Soil Pipe Institute)
 - 1. CISPI 301-11, "Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications," 2011.
 - 2. CISPI 310-09, "Specification for Couplings for use in connection with Cast Iron Soil Pipe for sanitary and storm drain, waste and vent piping applications."

- H. CS (Commercial Standard)

- I. IEEE (Institute of Electrical and Electronics Engineers)

- J. IMC (International Mechanical Code)

- K. IPC (International Plumbing Code)

- L. NEC (National Electrical Code)

- M. NEMA (National Electrical Manufacturers Association)

- N. NFPA (National Fire Protection Association)
 - 1. NFPA 54, "National Fuel Gas Code," 2006.
 - 2. NFPA 70, "National Electrical Code," 2008.

- O. OSHA (Occupational Safety and Health Administration)

- P. PHCC (National Standard Plumbing Code)

Q. UL (Underwriters' Laboratories)

1.5 SUBMITTALS

- A. General: Submit each item in this Section according to the Conditions of the Contract and the Division 01 Specification Sections.
- B. Maintenance data to be included in the operation and maintenance manual specified in Division 01. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing. Include data for the following:
 - 1. Pipe Materials
 - 2. Flow Measuring Systems
 - 3. Plumbing Specialties
- C. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- D. Certification of compliance with ASTM, ASME and ANSI manufacturing requirements for pipe, fittings, and specialties.
- E. Submit flange gasket bolt tightening sequence and torque requirements for review as part of gasket submittals.
- F. Product Data: Submit data on each type of pipe material and fittings. Submit manufacturer's catalogue information.
- G. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable grooved system manufacturer's style or series number.

1.6 QUALITY ASSURANCE

- A. ASME (American Society of Mechanical Engineers) Compliance; comply with:
 - 1. ASME B31.9, "Building Services Piping," latest edition.
 - 2. ASME B31.1, "Power Piping," latest edition.
- B. Qualify welding processes and welding operators according to AWS D1.1, "Structural Welding Code—Steel," 2001.
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- C. Gas Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.
- D. Regulatory Requirements: Comply with the requirements of the following additional codes:

1. NFPA 54, "National Fuel Gas Code," 1999, for gas piping materials and components, gas piping installations, and inspection, testing, and purging of gas piping systems.
2. International Mechanical Code (IMC), 2006.
3. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.
4. PHCC - National Standard Plumbing Code, latest edition.
5. HB 372 "Business Occupations and Professions – Plumbers – Lead Free Materials".

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years experience.
- B. Installer: Company specializing in performing work of this section with minimum 5 years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- C. Handling Flammable Liquids: Remove and legally dispose of liquid from drips in existing gas piping and handle cautiously to avoid spillage or ignition. Notify the gas supplier. Handle flammable liquids used by the installer with proper precautions, and do not leave on the premises from the end of one working day to the beginning of the next.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 SEQUENCING AND SCHEDULING

- A. Notification of Interruption of Service: Provide notification for all utility outages.
- B. Work Interruptions: When interruptions in work occur while repairs or alterations are being made to an existing piping system, leave the system in safe condition.
- C. Coordinate the installation of pipe sleeves for foundation wall penetrations.
- D. Coordinate the size and location of concrete pads. Cast anchor bolt inserts into pad.
- E. Coordinate the installation of roof piping support, and roof penetrations.

PART 2 - PRODUCTS

2.1 PIPE AND TUBE MATERIALS AND APPLICATION SCHEDULE

| System | Pipe Material | Fitting Material | Joint Material |
|--------|---------------|------------------|----------------|
|--------|---------------|------------------|----------------|

| | | | |
|---|---|---|---|
| Natural Gas | Steel Pipe: ASTM A53, Grade B, Schedule 40, black steel. | 2" and smaller: Malleable - Iron Threaded: ANSI B16.3, Class 150. Threads per ANSI B.1.20.1, and threadolets. | 2" and smaller: Threaded: American Standard for Pipe Threads ANSI B2.1. |
| | | 2 ½" and larger: Steel; ASTM A234, butt welded, long radius ells, and weldolets. Flanges: ANSI B16.5, weld neck, raised faced with gaskets. | 2 ½" and larger: Welded: Latest revision of Section IX, ASME Boiler and Pressure Vessel Code, Filler material per AWS D10.12. |
| All Domestic Hot Water, Cold Water, and Hot Water Circulating, Above ground within building located in or above the commercial kitchen & Boiler Room. | Copper Tube: ASTM B88, Type L, Seamless, Water Tube, hard-drawn temper. | Copper Tube: ASME B16.22, wrought copper, or copper alloy, solder joint, 150 lb. | For Pipe Sizes of 4" or less: ASTM B32, alloy Sb5 (95 percent tin and 5 percent antimony), with 0.2 percent maximum lead content. For Pipe Sizes over 4": Joints shall be silver soldered. |
| All Domestic Hot Water, Cold Water, and Hot Water Circulating, Above ground within building not located in or above the commercial kitchen. | Copper Tube: ASTM B88, Type L, Seamless, Water Tube, hard-drawn temper. | Copper Tube: ASME B16.22, wrought copper, or copper alloy, solder joint, 150 lb. | For Pipe Sizes of 4" or less: ASTM B32, alloy Sb5 (95 percent tin and 5 percent antimony), with 0.2 percent maximum lead content. For Pipe Sizes over 4": Joints shall be silver soldered. |
| | CPVC Tube: ASTM D 2846, ASTM F 441, ASTM F 442 | CPVC Tube: ASSE 1061, ASTM D 2846, ASTM F 437, ASTM F 438, ASTM F 439 | ASTM D 2846, ASTM F 493 |

| | | | |
|---|---|---|--|
| Cold Water, underground to 5' beyond building | 4" and larger: Ductile Iron: AWWA C151 or with AWWA C104 cement mortar lining. | 4" and Larger: Ductile Iron: AWWA C 110 or AWWA C153, with AWWA C104 cement mortar lining. | Push on or mechanical joints: AWWA C111. |
| | 3" and smaller: ASTM B88, Type K, water tube, annealed temper. | Copper Tube: ASME B16.22, cast copper alloy, 150 lb. | For Pipe Sizes of 4" or less: ASTM B32, alloy Sb5 (95 percent tin and 5 percent antimony), with 0.2 percent maximum lead content. For Pipe Sizes over 4": Joints shall be silver soldered. |
| Sanitary, and Sanitary Vents, Above Ground within building running in bedroom walls, in or serving the commercial kitchen or any public bathrooms. | Cast Iron; no hub, CISPI-301- 11. All pipe and fittings shall bear the Collective Trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International. | Cast Iron; no hub, CISPI-301. All pipe and fittings shall bear the Collective Trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International. | Couplings; Heavy Duty Type 300 Series Stainless Steel, ASTM C-1540 neoprene gasket, 3" wide for less than 5" pipe, 4" wide for 5-10", 5 1/2" wide for 12" pipe and larger. |
| Sanitary, and Sanitary Vents, Above Ground within building and not running in bedroom walls, in or serving the commercial kitchen or any public bathrooms | Cast Iron; no hub, CISPI-301- 11. All pipe and fittings shall bear the Collective Trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International. | Cast Iron; no hub, CISPI-301. All pipe and fittings shall bear the Collective Trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International. | Couplings; Heavy Duty Type 300 Series Stainless Steel, ASTM C-1540 neoprene gasket, 3" wide for less than 5" pipe, 4" wide for 5-10", 5 1/2" wide for 12" pipe and larger. |
| | Poly Vinyl Chloride (PVC); DWV pipe, ASTM D2665, Schedule 40, plain ends. | Socket ASTM D2665 | Solvent Cements, per ASTM D2564. |
| Sanitary, and Vents, Below Ground to 5 feet beyond building | Cast Iron; Service Weight, hub and spigot, ASTM A74. All pipes shall bare CISPI, collective trademark of CISPI and NSF. | Cast Iron; Service Weight, hub and spigot, ASTM A74. All pipes shall bare the collective trademark of CISPI and NSF. | Neoprene rubber gaskets and lubricant, ASTM C-564. |
| | Poly Vinyl Chloride (PVC); DWV pipe, ASTM D2665, Schedule 40 solid wall, plain ends. | Socket: ASTM D2665 | Solvent Cements, per ASTM D2564. |

| | | | |
|--|--|--|--|
| Air Conditioning Condensate and Equipment Drains | Copper Drainage Tube; DWV, ASTM B306. | Wrought copper and bronze drainage fittings, ANSI B16.29. | Soldered; ASTM B32, Alloy Sb5 (95 percent tin and 5% antimony), with 0.2 percent maximum lead content. |
|--|--|--|--|

- A. Alternate Piping System – Domestic Hot Water, Cold Water and Hot Water Circulating
1. IPS Grooved Copper Tubing System – Victaulic (or approved equal) roll grooved copper tube couplings, fittings, valves and other grooved components may be used as an option to soldered or brazed methods. All grooved components shall be of one manufacturer, and conform to local code approval and/or as listed by ANSI B31.1, ASME, UL/FM, IAPMO or BOCA. Grooved end product manufacturer to be ISO-9001 certified. System shall be applicable in systems operating between -30°F and +250°F. See manufacturer’s recommendations for gasket selection for services other than water.
 2. Copper Tube (Type L): ASTM B88 – Roll grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with Victaulic current listed standards conforming to ANSI/AWWA C606.
 3. Quality Assurance: To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.
 4. Mechanical Couplings: “Installation Ready” stab-on design, for direct ‘stab’ installation onto roll grooved copper tube without prior field disassembly and no loose parts. Housings shall be ASTM A536 ductile iron cast with offsetting, angle-pattern bolt pads coated with copper-colored enamel. Gasket shall be Grade “EHP” EPDM Suitable for domestic water and oil-free compressed air, or Grade “T” Nitrile suitable for air with oil vapors, and plated steel bolts and nuts. Victaulic Style 607 QuickVic™ (or comparable acceptable product.)
 5. Grooved End Fittings: ASME B16.22 wrought copper or ASME B16.18 bronze casing with copper-tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted).
 6. Flange Adapter: ASTM A536 ductile iron coated with copper-colored enamel, flat faced, designed for incorporating flanged components with ANSI Class 125 and 150 bolt-hole patterns to a grooved piping system. Victaulic Style 641.
 7. Mechanical-T Bolted Branch Outlet: Manufactured from ASTM A536 ductile iron and ASME B15.18 bronze castings with pressure-responsive, synthetic rubber sealing gasket. Victaulic Style 622 (or approved equal).

2.2 PIPING SPECIALTIES

- A. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents:
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8” (3mm) maximum thickness, except where thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125 cast-iron and cast bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.
 2. ASME B16.20, for grooved, ring joint, steel flanges.
 3. AWWA C110, rubber, flat face, 1/8 inch (3 mm) thick, except where other

thickness is indicated; and full-face or ring type, except where type is indicated.

- B. Flange Bolts and Nuts:
 - 1. ASME B18.2.1, carbon steel, except where other material is indicated.
- C. Plastic Pipe Flange Bolts, Washers and Nuts: Type and material recommended by piping system manufacturer, except where other type or material is indicated. Flat washers must be used under nuts and bolts. Gaskets to be full face, 1/8th inch thick, 70 durometer and of a material recommended for the application by the manufacturer.
- D. Unions: Lead Free, ANSI B16.39, Class 150, malleable iron; female pattern; brass to iron seat; ground joint. Threads shall conform to ANSI/ASME B1.20.1. Unions in copper piping shall be sweat fittings with bronze seats designed for 200 psig working pressure.
- E. Dielectric Unions: Lead Free, provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.
- F. Dielectric Fittings: Lead Free, provide dielectric fittings with appropriate end connections and piping materials. Dielectric fittings shall be as manufactured by Victaulic Style 47, Legend Valve Company Model T-575 or acceptable comparable product.
- G. Flexible Gas Piping Specialties:
 - 1. Striker Plates:
 - a. Striker plates shall be listed as part of the flexible gas piping system and shall be marked with the symbol of the Manufacturer and the listing Agency (CSA International).
 - b. Striker plates shall be made from carbon steel, heat-treated to RB40.
 - c. Striker plates shall be available in Quarter, Half, Three Quarter, Full and 6 x 17 configurations.
 - 2. Floppy Conduit:
 - a. Floppy conduit used for additional protection with striker plates (type RW electrical conduit) shall be made from galvanized steel.
 - 3. Accessories:
 - a. Termination mount fittings shall be used to provide a secure termination for tubing at moveable appliance locations and other "stub-out" points depending on building construction. Termination mount accessories shall consist of a plated carbon steel plate or brass mounting flange and an AutoFlare fitting. Fittings at termination mounts shall be accessible and provide a fitting joint exterior to the building floor or wall.
 - b. Meter termination fittings shall be used for exterior wall penetrations at meter locations and other penetrations. Meter termination shall consist of a plated carbon steel mounting plate and sleeve and an AutoFlare fitting. Fittings at meter termination outlets shall be accessible and provide a fitting joint exterior to the building.
 - c. Manifolds shall be made from malleable iron either plastic-coated or uncoated. Manifolds may be mounted using available manifold brackets or Gas Load Centers; they may alternatively be mounted using conventional pipe mounting methods.
 - d. Pounds-to-inches line pressure regulators shall be available in several sizes:
 - 1) REG 3: 1/2 inch threads
 - 2) REG 5A: 3/4 inch threads
 - 3) REG 7: 1-1/4 inch threads.

- 4) Regulators with Over Pressure Devices (OPD) are required for pressures above 2 psi. Regulators shall be listed per ASNI Z21.80 or a recognized national standard for pressure regulators. Regulators must be mounted in an accessible location.
 - e. Regulators with included approved vent-limiting device (REG 3 and REG 5A) shall not require venting to atmosphere provided they are mounted in a ventilated location (e.g. near a gas appliance which also required placement in a ventilated area). Ventilated locations include (but are not limited to) mechanical rooms, attics, garages and basements.
 - f. Approved vent limiters shall limit the fuel gas leakage to 2.5 cc per hour in the event of a diaphragm failure.
 - g. Shut-off valves shall be approved for fuel gas service and shall be rated for the pressure of the gas piping system installed. For elevated pressure sections an approved valve shall be located upstream from the pounds-to-inches regulator.
 - h. Overpressure protection devices shall be installed for elevated system higher than 2-PSI to prevent downstream pressure from exceeding 2-PSI in the event of regulator failure.
- H. Strainers – “Y” Type:
1. Strainers shall be lead free and of the basket or "Y" design, as manufactured by Watts, Nibco, Victaulic, Wilkens (A Zurn company) or an acceptable comparable product. Bodies shall have arrows clearly cast on the sides to show flow direction. Strainers shall be equipped with easily removable covers and standard stainless steel screens. Total area of perforations shall be not less than four times the cross section of the entering pipe.
 2. Provide valved blow off connections for all strainers full size of blow off tapping, with capped ends.
- I. Expansion Tanks:
1. Provide diaphragm type expansion tank as manufactured by Amtrol – Therm-X-trol, Taco Model No. PAX, or Bell and Gosset Model PTA.
 2. Size and number as indicated; construct of welded carbon steel for 125 psig working pressure, 375°F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a flexible diaphragm securely sealed into tank. Provide taps for air charging fitting, and drain plug. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1. Tanks shall be provided with integral base ring for vertical mounting.
- J. Basket Strainers:
1. Strainers shall be lead free as manufactured by, Watts, Nibco, Metraflex, or Spirax Sarco.
 2. 125 psig working pressure; high tensile cast-iron body (ASTM A126, Class B), flanged end connections, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.
- K. Recessed Non-freeze Wall Hydrants:
1. Refer to plumbing fixture schedule on the contract drawings for requirements.

- L. Vacuum Breakers:
1. Pipe Applied, Atmospheric Vacuum Breaker shall conform to ASSE 1001, with floating disc and atmospheric vent.
 2. Hose connection vacuum breakers shall conform to ASSE Standard 1011, with finish to match hose connection.
 3. Laboratory Faucet Vacuum Breakers: ASSE 1035, chrome plated; consisting of primary and secondary checks, intermediate vacuum breaker, threaded ends, 1/4" or 3/8" size as required, for continuous pressure application.
 4. Vacuum breakers shall be lead free.
- M. Reduced Pressure Backflow Preventers:
1. Reduced pressure type backflow preventers shall be lead free and shall be manufactured by Ames, Watts, Zurn/Wilkins, or an acceptable comparable product.
 2. Reduced-pressure-principle assembly consisting of shutoff valves on inlet and outlet and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between 2 positive seating check valves and comply with requirements of ASSE Standard 1013. Shut-off valves shall be provided in accordance with valves as specified in this section.
 3. Shut-off and check valves shall be the same model as provided for system in which backflow preventer is being installed.
- N. Double Check Valve Backflow Preventers:
1. Double check valve backflow preventers shall be lead free and shall be manufactured by Watts, Spence, or Wilkins.
 2. Double check backflow assemblies, conforming to ASSE 1015, consisting of shut-off valves on inlet and outlet and strainer on inlet. Include test cocks with 2 positive seating check valves for continuous pressure application.
- O. Water Filters / Water Softeners:
1. Refer to specification section 22 31 00 Domestic Water Softeners.
- P. Water Hammer Arresters:
1. Water hammer arresters shall be manufactured by Zurn, Josam, Precision Plumbing Products or JR Smith.
 2. ASSE 1010, or PDI WH-201, "Water Hammer Arresters," January, 1992, bellows or piston type with pressurized cushioning chamber. Sizes are based on water-supply fixture units, sizes "A" through "F" and PDI WH-201, sizes "A" through "F."
 3. Water Hammer Arresters shall be lead free when used with lead-free end user devices and piping that are required by Colorado law to be lead free.
- Q. Welding Materials: Comply, with Section II, Part C. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- R. Drainage System Specialties
1. Horizontal Backwater Valves: ASME A112.14.1, cast iron body, with removable bronze swing check valve, threaded or bolted cover, as manufactured by Josam, JR Smith, or Zurn.
 - a. Extension: Full size, service class, cast iron soil pipe extension to field

installed cleanout at floor.

2. Vent Caps: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and set-screws to secure to vent pipe.
3. Cleanouts: ASME A112.36.2M, cast-iron body with straight threads and gasket seal or taper threads for plug flashing flange and clamping ring, and a brass closure plug. Cleanouts for installation in floors not having membrane waterproofing may be furnished without clamping ring.

Cleanouts in Concrete Floors Zurn Model No. Z-1400 style to suit floor finish with round scoriated top.

Cleanouts in Finished Floors Zurn Model No. ZN-1400 style to suit floor finish with recessed top for tile or carpet.

Cleanouts in Piping Zurn Model No. ZN-1450-7 with bronze plug.

Cleanouts in Walls Zurn Model No. Z-1440-1 style to suit all finish, with vandalproof screws.

4. Floor Drains: Floor drains shall be as manufactured by Zurn, Jay R. Smith, Josam or Wade.
 - a. Floor Drains (Sanitary Waste): Zurn floor drain Z-415, dura coated cast iron body with no hub type 3 inch outlet, combination invertible membrane clamps, adjustable type 'B' 6 inch diameter nickel bronze strainer, trap primer connection and 3 inch no hub type deep seal trap.
 - b. Floor Sinks: Zurn floor sink, Model 1900-1, cast iron body, slotted grate, porcelain enamel interior and top, aluminum interior dome strainer, 1/2" trap primer connection.
5. Deep Seal Traps: Cast iron or bronze, with inlet and outlet matching connected piping, cleanout where indicated, and trap seal primer valve connection, as manufactured by Jay R. Smith, Josam, Zurn, or Ancon.
 - a. 2-Inch Size: 4-inch-minimum water seal.
 - b. 2 1/2 Inches and Larger: 5-inch-minimum water seal.
6. Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.
7. Air Gap Fittings: ASME A112.1.2, cast iron or cast bronze, with fixed air gap, inlet for drain pipe or tube, and threaded or spigot outlet.
8. Roof Drains: ASME A112.21.2M, cast-iron body, with combination flashing ring and gravel stop, cast-iron dome except where other dome material is specified, extension collars, underdeck clamp, and sump receiver.
 - a. Provide as manufactured by Zurn, Model Z-100, suitable for roof construction, or comparable products as manufactured by Jay R. Smith, Josam or Ancon.
9. Parapet Scupper: Zurn, Model Z-198, or comparable product as manufactured by Jay R. Smith, Josam or Ancon.
10. Downspout nozzle: Zurn, Model Z-199, or comparable product as manufactured by Jay R. Smith, Josam or Ancon.
11. Downspout boot:
 - a. 5x4 Downspout boot, Zurn Model Z91, or comparable product as manufactured by Josam and Ancon.
 - b. 4x3 Downspout boot, Zurn Model Z192, or comparable product as manufactured by Josam and Ancon.
 - c. Round inlet and outlet downspout boot, Zurn Model Z191-RD, or comparable product as manufactured by Josam and Ancon.

S. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where

required to conceal protruding fittings and sleeves.

1. Inside Diameter: Closely fit around pipe, tube, and insulation.
 2. Outside Diameter: Completely cover opening.
 3. Cast Brass: One-piece, with set-screw.
 4. Cast Brass: Split casting, with concealed hinge and set-screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome plate.
 5. Stamped Steel: One-piece, with set-screw and chrome-plated finish.
 6. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome-plated finish.
 7. Cast-Iron Floor Plate: One-piece casting.
- T. Dielectric Fittings: Lead free assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.
1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
 2. Insulating Material: Suitable for system fluid, pressure, and temperature.
 3. Dielectric Unions: Factory-fabricated, union assembly for 250-psig (1725kPa) minimum working pressure at a 180°F (82°C) temperature.
 4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig (1035kPa or 2070kPa) minimum pressure to suit system pressures.
 5. Dielectric-Flange Insulation Kits: Materials for flange isolation kits on pipes containing drinking/potable water (up to 280°F, 138°C) shall consist of the following components:
 - a. Isolating and Sealing Gasket:
 - 1) The full faced, NSF 61 certified, isolating and sealing gasket shall be LineBacker® 61™ Sealing Gasket (LB61) – Type “E”, 1/8” thick, G-10 retainer containing a precision tapered groove to accommodate the controlled compression of a EPDM quad-ring sealing element. Sealing element placement shall accommodate either flat, raised face or RTJ flanges.
 - 2) The quad-ring seal shall be pressure energized. The G-10 retainer shall have a 550 volts/mil dielectric strength and a minimum 50,000 psi compressive strength.
 - 3) The full faced flange isolating gasket (weld-neck) shall be equal to or slightly smaller than the bore of the flange; (slip-on) shall be equal to or smaller than the I.D. of mating pipe.
 - b. Full Length Bolt Isolating Sleeves:
 - 1) One full length G-10 Sleeve (extending half way into both steel washers) for each flange bolt. The G-10 shall be a 1/32 inch thick tube with a 400 volts/mil dielectric strength and water absorption of 0.10% or less.
 - c. Washers:
 - 1) Two, 1/8 inch thick, G-10 isolating washers for each bolt. Their compressive strength shall be 50,000 psi, dielectric strength 550 volts/mil and water absorption 0.10% or less.
 - 2) Two, 1/8 inch thick zinc plated, hot rolled steel washers for each bolt. The I.D. of all washers shall fit over the isolating sleeve and both the steel and isolating washers shall have a same I.D. and O.D.
 - d. Quality:
 - 1) Flange isolating kits shall be manufactured at a facility that has a registered ISO 9001:2008 Quality Management System. Submittals shall include copy of valid ISO registration and NSF

61 certification.

e. Basis of Design:

- 1) Flange gasket kits shall be manufactured by PSI-Pipeline Seal and Insulator, Inc., Houston, Texas. Comparable products shall be submitted as required under Section Product Requirements for comparable product review. Products should be submitted to engineer 10 days prior to bid due date.
6. Dielectric Couplings: Lead free galvanized-steel coupling, having inert and noncorrosive, thermoplastic lining, with threaded ends and 300-psig (2070kPa) minimum working pressure at 225°F (107°C) temperature.
7. Dielectric Nipples: Lead free electroplated steel or ductile nipple, having inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig (2070kPa) working pressure at 230 °F (110°C) temperature. Victaulic Style 47.

U. Gas System Specialties:

1. Flexible Gas Hoses: Dormont 1600 Series Safe-T-Link by T&S Brass and Bronze Works, Inc., or an acceptable comparable product.

V. Pipe Guides:

1. Systems greater than 70°F operating temperature: Provide Erico (formerly known as Michigan) Model No. 650, or an acceptable comparable product.
2. Systems less than 70°F operating temperature: Provide Erico (formerly known as Michigan) Model No. 651, or an acceptable comparable product.

W. Pipe Anchors:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened Portland cement concrete, and tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.
6. Concrete: Portland cement mix, 3000 psi minimum. Refer to Division 03 Specifications for formwork, reinforcement, and concrete.
7. Grout: Refer to Division 23 Section "Common Work Results for Mechanical."

X. Thermometers, General

1. Scale Range: Temperature ranges indicated in degrees Fahrenheit shall be provided for services listed as follows:

- a. Domestic Hot Water: 30 to 180°F, with 2-degree scale divisions.
- b. Domestic Cold Water: 0 to 100°F, with 2-degree scale divisions.
- 2. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.
- 3. Liquid-in-glass Thermometers
 - a. Provide as manufactured by H.O. Trerice, Weiss Instruments, or Weksler Instrument Corp.
 - b. Description: ASTM E1, liquid-in-glass thermometer.
 - c. Case: Die-cast and aluminum-finished in baked-epoxy enamel, glass front, spring secured, 9 inches (230 mm) long.
 - d. Adjustable Joint: Finished to match case, 180° (3.1rad) adjustment in vertical plane, 360° (6.3rad) adjustment in horizontal plane, with locking device.
 - e. Tube: Red-reading, organic liquid-filled instead of mercury-filled, with magnifying lens.
 - f. Scale: Satin-faced nonreflective aluminum with permanently etched markings.
 - g. Stem: Copper-plated steel, aluminum, or brass for a separable socket of length to suit installation.
- 4. Direct-mounting Filled-system Dial Thermometers
 - a. Provide as manufactured by H.O. Trerice Co., Weiss Instruments, Inc., or Weksler Instrument Corp.
 - b. Description: Vapor-actuated universal-angle dial thermometer.
 - c. Case: Drawn steel or cast aluminum, with 4-1/2-inch (115mm) -diameter glass lens.
 - d. Adjustable Joint: Finish to match case, 180° (3.1rad) adjustment in vertical plane, 360° (6.3rad) adjustment in horizontal plane, with locking device.
 - e. Thermal Bulb: Copper with phosphor-bronze Bourdon pressure tube.
 - f. Movement: Brass, precision geared.
 - g. Scale: Progressive satin-faced nonreflective aluminum with permanently etched markings.
 - h. Stem: Copper-plated steel, aluminum, or brass for a separable socket of length to suit installation.
- 5. Remote-reading, Filled-system Dial Thermometers
 - a. Provide as manufactured by H.O. Trerice Co., Weiss Instruments, Inc., or Weksler Instrument Corp.
 - b. Description: Vapor-actuated remote-reading dial thermometer.
 - c. Case: Drawn steel or cast aluminum, with 4 1/2 -inch (115mm) -diameter glass lens.
 - d. Movement: Brass, precision geared.
 - e. Scale: Progressive satin-faced nonreflective aluminum with permanently etched markings.
 - f. Tubing: Bronze double-braided armor-over-copper capillary of length to suit installation.
 - g. Bulb: Copper with separable socket for liquids; averaging element for air.
- 6. Thermometer Wells
 - a. Description: Brass or stainless-steel thermometer well, with heat conducting compound.
 - b. Pressure Rating: Not less than piping system design pressure.
 - c. Stem Length: To extend 2 inches (50 mm) into fluid or center of pipe, whichever is shorter.
 - d. Extension for Insulated Piping: 2 inches (50 mm) nominal, but not less than thickness of insulation.
 - e. Threaded Cap Nut: With chain permanently fastened to well and cap.

- f. BAS connected temp sensors/wells for mixing valve in/out water lines all hot and return water lines

Y. Pressure Gages, General

1. Provide as manufactured by H.O. Trerice Co., Weiss Instruments, Inc., or Weksler Instrument Corp.
 - a. Description: ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage, with bottom connection.
 - b. Case: Drawn steel, brass, or aluminum with 4 1/2 -inch (115mm) -diameter glass lens.
 - c. Connector: Brass, 1/4" inch (8mm) NPS.
 - d. Scale: White-coated aluminum, with permanently etched markings.
 - e. Accuracy: Plus or minus 1 percent of range span.
 - f. Range: Conform to the following:
 - 1) Vacuum: 30 inches Hg of vacuum to 15 psig of pressure.
 - 2) Fluids Under Pressure: From zero to two times operating pressure.
 - g. Snubbers: 1/4" inch (8mm) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.
 - h. Needle Valve: Exceed pressure and temperature rating of installation.

Z. Test Plugs:

1. Provide as manufactured by Flow Design, Inc., Peterson Equipment Co., or H.O. Trerice.
2. Description: Nickel-plated brass-body test plug in 1/2" inch fitting.
3. Body: Length as required to extend beyond insulation.
4. Pressure Rating: 500 psig minimum.
5. Core Inserts: 2 self-sealing valve types, suitable for inserting a 1/8" inch (3mm) outside-diameter probe from a dial thermometer or pressure gage.
6. Core Material: According to the following for fluid and temperature range:
 - a. Air, Water, Oil, and Gas: 20°F to 200°F, neoprene rubber.
 - b. Air and Water: Minus 30°F to 275°F (minus 35 to 136° C), ethylene-propylene-diene-terpolymer (EPDM) rubber.
7. Test-Plug Cap: Gasketed and threaded cap, with retention chain.
8. Test Kit: Provide test kit consisting of 1 pressure gage and gage adapter with probe, 2 bimetal dial thermometers and a carrying case.
9. Pressure Gage and Thermometer Ranges: Approximately 2 times systems operating conditions.

AA. Thermostatic Mixing Valve (MV-2.2-1)

1. Digital Mixing Center (DMC)
 - a. Digital Re-Circulating Valve shall be supplied pre-piped and pressure tested as a lead free Digital Mixing Center complete with inlet hot water, inlet cold water, outlet mixed water, inlet re-circulation return water and outlet return to heater water connections.
 - b. DMC shall comprise check valves, strainers, thermometers, pressure gauges, ball valves, inlet hot water to outlet mixed water by-pass and shall be mounted onto an enameled steel frame.
2. DIGITAL RE-CIRCULATING VALVE (DRV)
 - a. Re-Circulating Valve shall be digital of lead free stainless steel/polymer construction.
 - b. DRV shall have 1 1/2" inlet/outlet connections, deliver a mixed water flow

of 41GPM @ 7.5ft/sec and shall have no minimum system draw off requirement.

- c. DRV shall have all of the following operational capabilities:
 - 1) +/- 2F water temperature control
 - 2) 2F minimum inlet to outlet water temperature differential
 - 3) Automatic shutoff of hot water flow upon cold water inlet supply failure.
 - 4) Automatic shutoff of hot water flow in the event of a power failure
 - 5) Programmable set point range of 81-158°F (27-70°C)
 - 6) Programmable thermal disinfection mode
 - 7) Programmable 1st level hi/lo temp alarm display
 - 8) Programmable temperature error level for safety shutdown
- d. DRV shall have all of the following connectivity capabilities:
 - 1) SPCO relay outputs which are energized during operation.
 - 2) LCD display which indicates: set point, delivered temperature, error codes and alarm conditions.
 - 3) MODBUS 485 port for remote set point adjustment and remote operating temperature visibility.
 - 4) RS485 Serial Port for connection to a performance matched hot water monitoring system.
- e. DRV shall be compliant with ASSE Standard 1017 and CSA B125 and so certified and identified.
- f. DRV shall be UL listed and identified.
- g. BRAIN shall be tied back directly to the JACE via BACNET MSTP

2.3 SLEEVE PENETRATION SYSTEMS

- A. General: Provide protective sheathing or wrapping between metal pipes and sleeves to prevent pipes from corroding.
- B. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, structure members or other building parts. Sleeves through walls and floors shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through freely with space for movement for all piping which passes through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.
- C. Sleeves through floors shall be flush with the floor except for sleeves passing through Mechanical Rooms which shall extend $\frac{3}{4}$ " above the floor. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves.
- D. Sleeves through walls and floors shall be sealed.
- E. Penetrations through fire rated walls and floors.
 - 1. All plumbing pipe and fixture penetrations through fire rated floors and walls shall be provided and firestopped using UL classified through penetration firestop devices as manufactured by ProSet Systems, Inc. The fire rating of the firestop device shall be equivalent or greater than the fire rating of the floor or wall penetrated. All firestop devices shall be provided in accordance with manufacturer's instructions.
 - a. Penetrations by hot and cold domestic water lines shall be provided using ProSet System A firestop devices.
 - b. Penetrations by cast iron drain, waste and vent piping, bathtub drains, water closet openings, shower drains and floor drains shall be provided

- using ProSet System B firestop devices.
2. All penetrations by fire protection water lines through fire rated floors and walls shall be provided and firestopped using UL classified through penetration firestop devices, System A, as manufactured by ProSet Systems Inc.
 - a. The fire rating of the firestop device shall be equivalent to or greater than the fire rating of the floor or wall penetrated.
 - b. All firestop devices shall be provided in accordance with manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify excavations and trenches are ready to receive piping.
- B. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of installed devices. Do not proceed with installation until unsatisfactory conditions have been corrected.
- C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- D. Examine substrates and conditions under which pipe expansion joints, pipe alignment guides, and pipe anchors are to be installed. Do not proceed until unsatisfactory conditions have been corrected.
- E. Do not enclose, cover, or put into operation any piping system until it has been inspected by the authority having jurisdiction and tested as specified herein.

3.2 PREPARATION

- A. Preparation For Testing: Prepare water piping and condensate piping in accordance with ASME B31.9, and as follows:
 1. Test for leaks and defects in new piping systems and parts of existing systems 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 system tested.
 2. Leave joints including welds un-insulated and exposed for examination during the test.
 3. Provide temporary restraints for expansion joints, which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
 4. Flush system with clean water. Clean strainers.
 5. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
 6. Install relief valve set at a pressure no more than one-third higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

3.3 EXCAVATION

- A. Refer to Division 31 specifications for additional requirements.

B. Excavation for Utility Trenches

1. Excavate trenches to indicated gradients, lines, cross sections, elevations and subgrades.
2. Excavate trenches to uniform widths to provide the following clearance on each side of pipe.
 - a. Clearance: 8 inches (200 mm) minimum each side of pipe.
3. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, etc. Remove projecting stones and sharp objects along trench subgrade.
 - a. For pipes and conduit less than 6 inches (150 mm) in nominal diameter and flat-bottomed, hand-excavate trench bottoms and support pipe on an undisturbed subgrade.
 - b. For pipes 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
 - c. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

C. Unauthorized Excavation

1. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation.

D. Backfill

1. Place and compact backfill in excavations promptly, but not before completing the following:
 - a. Construction below finish grade including, where applicable, subdrainage, damp proofing, water proofing and perimeter insulation.
 - b. Surveying locations of underground utilities for Record Documents.
 - c. Testing and inspecting underground utilities.
 - d. Removing concrete formwork.
 - e. Removing trash and debris.
 - f. Removing temporary shoring and bracing, and sheeting.
 - g. Installing permanent or temporary horizontal bracing on horizontally supported walls.
 - h. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the utility pipe.
 - 1) Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping to avoid damage or displacement of piping. Coordinate backfilling with utilities testing.
 - i. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
 - j. Place and compact final backfill of satisfactory soil to final subgrade elevation.
 - k. Install detectable warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavement and slabs.

E. Compaction of Soil Backfills and Fills

1. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
2. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
3. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
 - a. Under structure, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 92 percent.
 - b. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
 - c. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) subgrade and compact each layer of backfill or fill soil material at 85 percent.
 - d. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.
 - e. Against foundation walls, scarify and recompact with and operated equipment within 3 feet of wall to avoid overstressing the wall at 95 percent.

3.4 INSTALLATION OF PIPING, GENERAL

A. Piping

1. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
2. Install concentric reducers where pipe is reduced in size in the direction of flow, with bottoms of both pipes and reducer flush.
3. Connect branch piping to mains from top of main, unless specific otherwise for specific systems.
4. Install supports in accordance with Specification Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
5. Make changes in directions and branch connections using fitting, pull tees shall not be permitted.
6. Install flanges, flange kits, and unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
7. Install dielectric unions where piping of dissimilar metals are joined.
8. Install flanges on valves, apparatus, and equipment having 2 1/2" inch and larger connections.
9. Install flexible connectors at inlet and discharge connections to pumps and other vibration producing equipment.
10. Install strainers on the supply side of each control valve, pressure regulating valve, and elsewhere as indicated. Install 3/4" inch NPS nipple and ball valve in blow down connection of strainers. Use same size nipple and valve as blow-off connection of strainer.
11. Anchor piping to ensure proper direction of expansion and contraction. Anchors shall attach to the building structure to prevent pipe movement. Anchors shall be installed in such a manner to prevent damage to the building structure. Anchors

- shall be securely welded to the piping being anchored. Install expansion loops and joints as indicated on the Drawings.
12. Install pipe sleeves at all wall and floor penetrations. Provide protective sheathing or wrapping between metal pipes and sleeves to prevent pipes from corroding.
 13. Seal pipe penetrations of fire separations specified in Division 07 Specifications.
 14. Hanger, supports, and anchors are specified in Specification Section 22 05 29 - "Hangers and Supports for Plumbing Piping and Equipment."
 15. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, $\frac{3}{4}$ " ball valve, and short $\frac{3}{4}$ " threaded nipple and cap.
 16. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inch and larger shall be sheet metal.
 17. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.
 18. In concealed locations where piping, other than cast iron or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than $1\frac{1}{2}$ " from the nearest edge of the member, the pipe shall be protected by steel shield plates. The plates shall be made of gage 16 and shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2" above sole plates and below tip plates.
 19. Domestic water piping shall not be routed through unconditioned space under any circumstances.

B. Joint Construction

1. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ANSI/ASME B1.20.1.
 - a. Cut threads full and clean using sharp dies.
 - b. Ream threaded ends to remove burrs and restore full inside diameter.
 - c. Apply pipe joint lubricant or sealant, suitable for the service for which the pipe is intended, on the male threads at each joint.
 - d. Tighten joint to leave not more than 3 threads exposed.
 - e. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - f. Align threads at point of assembly.
 - g. Apply appropriate tape or thread compound to the external pipe threads.
 - h. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
 - i. Damaged Threads: Do not use pipe with threads which are corroded or damaged.
 - j. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
2. Welded Joints: Weld pipe joints in accordance with ASME B31.9 and ASME B31.1, where required by COMAR.
3. Brazed Joints: For copper tube and fittings, braze joints in accordance with ASME B31, "Standard Code for Pressure Piping" and AWS "Brazing Manual."
 - a. Remove stems, seats, and packing of valves and accessible internal parts of valves before brazing.
 - b. Braze joints in accordance with ASME B31.1.
 - c. Fill the tubing and fittings during brazing with nitrogen under a continuous purge to prevent formation of scale.

- d. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
 - e. Heat joints to proper and uniform temperature.
 - f. **WARNING:** Some filler metals contain compounds which produce highly toxic fumes when heated. Provide adequate ventilation and avoid breathing fumes.
- 4. **Mechanical Joints:** Follow grooved-end mechanical coupling manufacturer's written instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved system manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
 - 5. Tongue and recess couplings (required a gap and specific torque value to obtain specified performance) will only be permitted if a torque wrench is used for installation. Required torque shall be in accordance with manufacturer's latest installation instructions and best practices recommendations.
 - 6. **Flanged Joints:** Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.
 - 7. **Grooved Joints:** Assemble joints in accordance with fitting manufacturers written instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved system manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
 - 8. **CPVC Pipe Joint Construction:** Conform to ASTM D2846.

3.5 INSTALLATION OF THREADED CONNECTIONS

- A. Align threads at point of assembly.
- B. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
- C. Assemble joint, wrench tight.

3.6 INSTALLATION OF FLANGED CONNECTIONS

- A. Align flange surfaces parallel.
- B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- C. For dead-end service, butterfly valves require flanges both upstream and downstream for

proper shutoff and retention.

3.7 INSTALLATION OF METERS, GAGES, THERMOMETERS, ETC.

A. Meters/Gages

1. General: Where indicated, install meters and gages of types, sizes, capacities, and with features indicated.
2. Install meters, gages, and accessories according to manufacturers' written instructions for applications where used.
3. Install thermometers and adjust vertical and tilted positions.
4. Remote-Reading Dial Thermometers: Install in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.
5. Thermometer Wells: Install in vertical position in piping tees where thermometers are indicated.
 - a. Install wells with stem extending minimum of 2 inches (50 mm) into fluid.
 - b. Install wells with stem extending to center of pipe.
 - c. Fill wells with oil or graphite and secure caps.

B. Pressure Gages

1. Install pressure gages in piping tee with pressure gage face located on pipe at most readable position.
2. Install in the following locations and elsewhere as indicated:
 - a. At suction and discharge of each pump.
 - b. At building water service entrance.
 - c. On expansion tanks.
3. Needle Valves: Provide 1/4" needle valve in piping tee, with snubber.

C. Installation - Test Plug

1. Install test plugs in piping tees where indicated, located on pipe at most readable position. Secure cap.

D. Installation - Flow-measuring System, Flow Element And Meter

1. General: Install flow meters for piping systems located in accessible locations at most readable position.
2. Locations: Install flow measuring elements and meters at discharge of each pump and elsewhere as indicated.
3. Differential-Pressure-Type Flow Elements: Install minimum straight lengths of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions.
4. Install connection fittings for attachment to portable flow meters in readily accessible locations.
5. Permanently Mounted Meters for Flow Elements: Install meters on walls or brackets in accessible locations.
6. Install connections, tubing, and accessories between flow elements and meters as prescribed by manufacturer's written instructions.

E. Connections - Meters

1. Install meters and gages adjacent to machines and equipment to allow servicing and maintenance.
2. Connect flow-measuring-system elements to meters.

3. Connect flow-meter transmitters to meters.
4. Make electrical connections to power supply and electrically operated meters and devices.

F. Adjusting and Cleaning - Meters

1. Calibrate meters according to manufacturer's written instructions, after installation.
2. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.
3. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

G. Portable Meters

1. Turn-over portable meters to the Owner upon completion of the project.

3.8 INSTALLATION OF PIPING SPECIFIC TO NATURAL GAS

A. Preparation

1. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified hereinafter in this section to determine that all equipment is turned off in the piping section to be affected.
2. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

B. Piping

1. General: Conform to the requirements of NFPA 54.
2. Concealed Locations: Except as specified below, install concealed gas piping in an air-tight conduit constructed of Schedule 40, seamless black steel with welded joints. Vent conduit to the outside and terminate with a screened vent cap.
 - a. Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not such spaces are used as a plenum.
 - 1) Valves shall not be located in such spaces.
 - 2) Piping installed in plenums shall be welded.
 - b. In Floors: Piping installed in floors shall be as specified for underground natural gas piping.
 - c. Piping In Partitions: Concealed piping shall not be located in solid partitions. Tubing shall not be run inside hollow walls or partitions unless protected against physical damage. This does not apply to tubing passing through walls or partitions.
 - d. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumb waiter, elevator shaft, in floor construction, and below floor slabs. This does not apply to accessible above-ceiling space specified above.
3. Drips Legs: Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.
 - a. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of 3 pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.
4. Install gas piping at a uniform grade of 1/4" inch in 15 feet, upward in direction of

- risers.
- 5. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.
- 6. Pipe Joint Construction
 - a. Threaded Joints: Refer to NFPA for guide for number and length of threads for field threading steel pipe.
- 7. Terminal Equipment Connections
 - a. Install shut-off valve upstream and within 6 feet of gas appliance. Install a union or flanged connection downstream from the gas cock to permit removal of controls.
 - b. Drip Legs: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a minimum of 3 pipe diameters in length.
- 8. Electrical Bonding And Grounding
 - a. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70.
 - b. Do not use gas piping as a grounding electrode.
 - c. Conform to NFPA 70 for electrical connections between wiring and electrically operated control devices.
- 9. Flexible pipe connections shall not be permitted. All connections shall be hard piped.

3.9 INSTALLATION OF PIPING SPECIFIC TO DRAINAGE AND VENT SYSTEMS

A. Service Entrance Piping

- 1. Extend building storm drain piping and connect to building storm sewer piping of size and in location indicated for service entrance to building. Install cleanout and extension to grade at connection of building storm drain and building storm sewer.
- 2. Extend building sanitary drain piping and connect to sanitary sewer piping of size and in location indicated for service entrance to building. Install cleanout and extension to grade at connection of building sanitary drain and building sanitary sewer.
- 3. Install sleeve and mechanical sleeve seal at service penetrations through foundation wall for watertight installation.

B. General

- 1. Install cast-iron soil pipe and cast-iron soil pipe fittings according to the latest version of the CISPI "Cast Iron Soil Pipe and Fittings Handbook, 2006," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- 2. Make changes in direction for drainage and vent piping using appropriate Y branches, Y branches with 1/8 bends, and long-sweep 1/4, 1/5, 1/6, 1/8, and 1/16 bends. Sanitary tees and short-sweep quarter vends may be used on vertical stacks of drainage lines where change in direction of flow is from horizontal to vertical. Use long-turn double-Y-branch and 1/8-bend fittings where 2 fixtures are installed back to back or side by side and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Make no change in direction of flow greater than 90°. Where different sizes of drainage pipes and fittings are connected, use proper size standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.
- 3. Lay buried building drains beginning at low point of each system, true to grades and alignment indicated, with unbroken continuity of invert. Place hub or bell ends of piping facing upstream. Install required gaskets according to

manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in piping and pull past each joint as completed.

4. Install drainage and vent piping at the following minimum slopes, except where another slope is indicated:
 - a. Sanitary Building Drain: 1/4" inch per foot (2 percent) for piping 3 inches and smaller; 1/8" inch per foot (1 percent) for piping 4 inches and larger.
 - b. Horizontal Sanitary Drainage Piping: 1/4" inch per foot (2 percent).
 - c. Storm Building Drain: 1/8" inch per foot (1 percent).
 - d. Horizontal Storm Drainage Piping: 1/4" inch per foot (2 percent).
 - e. Vent Piping: 1/8" inch per foot (1 percent).
5. Install underground PVC drainage piping according to ASTM D2321.
 - a. Rigid plastic and hubless drainage piping, including offsets and jumps, shall rest on a continuous bed of sand, gravel or crushed stone, a minimum of four (4) inches deep below the pipe; maximum aggregate size shall be three-quarter (3/4) inches (MD #6 and smaller). Bedding material shall be placed on both sides of the pipe equal in depth to the pipe diameter and hand compacted to prevent deformation of pipe from top loading. Piping shall be laid in a trench, except where soil conditions or grade do not permit such practices.
 - b. Drainage piping above grade and not fully confined within a trench shall rest on bedding material at least thirty (30) inches wide. Horizontal and vertical alignment of piping shall be maintained by three-eighths (3/8) inch minimum diameter steel "J" hooks, "U" hooks or equivalent hold-down devices driven into the ground every eight (8) feet, at changes of direction 45° or more, and at ends of runs. The length of hold-down devices shall be sufficient, depending on soil type, to prevent easy removal, but not less than twenty-four (24) inches long.
6. Sleeves are not required for cast-iron soil pipes passing through concrete slab, without membrane waterproofing, on grade.
7. Install PVC drainage pipe and fittings according to ASTM D2665.
8. Install all buried plastic pipe in accordance with ASTM D2321.
9. Joint Construction
 - a. Grooved Pipe and Grooved-Pipe Fittings Joints: Assemble joints with coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
 - b. Cast-Iron Soil Pipe and Cast-Iron Soil Pipe Fitting Joints: Make joints according to recommendations in the latest version of the CISPI "Cast Iron Soil Pipe and Fittings Handbook, Volume I," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1) Compression Joint: Make with neoprene gasket matching class of pipe and fittings.
 - 2) Hubless Joint: Make with neoprene gasket and sleeve or clamp.
 - c. PVC DWV Pipe: Join PVC drainage pipe and fittings according to ASTM D2665.
 - d. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F402, for safe handling during joining of plastic pipe and fittings with solvent cements.
10. Pipe Attachments:
 - a. Riser Clamps: MSS Type 8 or Type 42 for vertical runs.
 - b. Adjustable Steel Clevis Hangers: MSS Type 1 for individual straight horizontal runs 100 feet and less.
 - c. Adjustable Roller Hangers: MSS Type 43 for individual straight horizontal runs longer than 100 feet.
 - d. Spring Cushion Rolls: MSS Type 49, where indicated, for individual straight horizontal runs longer than 100 feet.

- e. Pipe Rolls: MSS Type 44 for multiple straight horizontal runs 100 feet or longer. Support pipe rolls on trapeze.
- f. Spring Hangers: MSS Type 52 for support of base of vertical runs.
- 11. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to the manufacturer's written instructions.
- 12. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

C. Connections

- 1. Drainage Runouts to Fixtures: Provide drainage and vent piping runouts, with approved trap, of sizes indicated, but not smaller than required by plumbing code, to plumbing fixtures and drains.
- 2. Locate drainage piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.
- 3. Supply Runouts to Fixtures: Install hot- and cold-water supply piping runouts to fixtures of sizes indicated, but not smaller than required by plumbing code.
 - a. Drainage Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated, but not smaller than required by plumbing code.
 - b. Locate drainage piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.
 - c. Interceptor Connections: Connect piping, flow control fittings, and accessories as indicated.
 - 1) Grease Interceptors: connect inlet and outlet to unit, and flow control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff type unit.
 - d. Electrical Connections: Power wiring and disconnect switches are specified in Division 26.
 - 1) Grounding & Bonding for Electrical Systems: Connect unit components to ground according to the National Electrical Code and Specification Section "Grounding."

D. Protection

- 1. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- 2. Place plugs in ends of uncompleted piping at end of day or when work stops.
- 3. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with 2 coats of a water-based latex paint.

E. Drainage And Vent System Specialties

- 1. Install backwater valves in building drain piping as indicated. For interior installation, provide cleanout deck plate (cover) flush with floor and centered over backwater valve cover and of adequate size to remove valve cover for service.
- 2. Install expansion joints on vertical risers, stacks, and conductors as indicated.
- 3. Cleanouts
 - a. Install cleanouts in above-ground piping and building drain piping as indicated, and where not indicated, according to the following:
 - 1) Size same as drainage piping up to 4-inch size. Use 4-inch size for larger drainage piping except where larger size cleanout is indicated.
 - 2) Locate at each change in direction of piping greater than 45°.
 - 3) Locate at minimum intervals of 50 feet for piping 4 inches and smaller and 100 feet for larger piping.

- 4) Locate at base of each vertical soil or waste stack.
- b. Install cleanout deck plates (covers), of types indicated, with top flush with finished floor, for floor cleanouts for piping below floors.
- c. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- d. Install flashing flange and clamping device with each stack and cleanout passing through floors having waterproof membrane.
- 4. Floor Drain Installation
 - a. Install floor drains according to manufacturer's written instructions, in locations indicated.
 - b. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.
 - c. Trap drains connected to sanitary building drain. Provide trap primers for all traps.
 - d. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
 - e. Position drains for easy accessibility and maintenance.
- 5. Interceptor Installation
 - a. General: Comply with unit manufacturer's written instructions and with local authority for trapping and venting.
 - b. Install units with clear space for servicing.
 - c. Install waste piping, flow control fitting, vent piping, and accessories as indicated.
- 6. Flashing Installation
 - a. Refer to Division 07 Specifications for requirements.

3.10 FIELD QUALITY CONTROL

- A. Testing shall be performed by Installer of system being tested in presence of the Owner's representative. Provide seven (7) day advance notice prior to testing of systems.
- B. Inspection of Piping Systems:
 - 1. Do not enclose, cover, or put into operation any piping system until it has been inspected and approved by Owner's Representative.
 - 2. During progress of installation, notify the authority having jurisdiction seven (7) days prior to time such inspection must be made. Perform tests specified in presence of Owner's Representative.
 - a. Roughing-In Inspection: Arrange for inspection of piping system after system roughing-in, before concealing, and prior to setting fixtures.
 - b. Final Inspection: Arrange for final inspection by Owner's Representative to observe tests specified below and to ensure compliance with requirements of Owner's Representative.
 - 3. Re-inspections: Make required corrections and arrange for reinspection by Owner's Representative when piping system fails to pass test or inspection.
 - 4. Reports: Prepare and submit inspection reports for approval by Owner's Representative.
- C. Test domestic water, sanitary waste, vent, and storm drainage piping systems in accordance with all applicable codes and the local authority having jurisdiction.
- D. Leak Testing
 - 1. Natural Gas
 - a. Inspect, test, and purge natural gas systems in accordance with NFPA

- 54, "National Fuel Gas Code", 1999, and local utility requirements.
- b. Cap and fill systems, with oil-free, dry air or gaseous nitrogen, to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate the test source and let stand for 4 hours to equalize temperature. Refill system, if required, to test pressure and hold pressure for 2 hours with no drop in pressure.
 - c. Purging:
 - 1) Removal from Service: When piping is to be opened for servicing, addition, or modification, the section to be worked on shall be turned off from the gas supply at the nearest convenient point and the line pressure vented to the outdoors or to ventilated areas of sufficient size to prevent accumulation of flammable mixtures. The remaining gas in the piping shall be dispersed with an inert gas.
 - d. Placing in Operation: When piping full of air is placed in operation, the air in the piping shall be displaced with an inert gas, and the inert gas shall then be displaced with fuel.
 - e. Discharge of Purged Gases: The open end of piping systems being purged shall not discharge into confined spaces or areas where there are sources of ignition unless precautions are taken to perform this operation in a safe manner by ventilation of the space, control or purging rate, and elimination of all hazardous conditions.
2. Domestic Water
- a. Perform tests prior to installation of piping insulation.
 - b. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
 - c. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.
 - d. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
 - e. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the ASE value in Appendix A of ASME B31.9, "Code For Pressure Piping, Building Services Piping."
 - f. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
 - g. Test backflow preventors in accordance with the local plumbing code and requirements of the authority having jurisdiction.
3. Drainage And Vent Piping Systems
- a. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open-jointed drain tile, test piping of plumbing drainage and venting systems on completion of roughing-in piping installation. Tightly close all openings in piping system and fill with water to 10 feet head of water. Water level shall not drop during the period from 15 minutes before inspection starts through completion of inspection. Inspect joints for leaks.
 - b. Finished Plumbing Test Procedure: After plumbing fixtures have been

set and their traps filled with water, test connections and prove gastight and watertight. Plug stack openings on roof and building drain where it leaves the building and introduce air into the system equal to pressure of 1-inch water column. Use a U tube or manometer inserted in the trap of a water closet to measure this pressure. Air pressure shall remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

- c. Repair leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
- d. Prepare reports for tests and required corrective action.

3.11 CLEANING (Refer to Specification Section 22 25 01 - "Plumbing Piping System Cleaning and Treatment.")

3.12 PAINTING

- A. Mechanical Room Piping: All piping including insulated systems located in Mechanical Rooms and equipment spaces shall be completely painted. Refer to Division 09 Specifications. Colors shall be as selected by the Architect.
- B. Touching Up: Clean field welds and abraded areas of paint. Use same materials as used for shop painting. Comply with SSPC-PA 1, "Shop, Field, and Maintenance Painting," requirements for touching up field painted surfaces.
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.
- D. Plastic Pipe shall be painted with Exterior Grade Latex Paint. DO NOT USE EPOXY OR OIL BASE PAINTS ON PLASTIC PIPE.

END OF SECTION

SECTION 22 0516

EXPANSION FITTINGS AND LOOPS 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, and all sections of Division 22.

1.2 SUMMARY

- A. Section includes:
 - 1. Flexible pipe connectors.
 - 2. Expansion joints.
 - 3. Flexible Pre-Fabricated expansion loops.
 - 4. Pipe alignment guides.
 - 5. Pipe anchors.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Section 22 05 00 - "Common Work Results for Plumbing."
 - 2. Section 22 05 29 - "Hangers and Supports for Plumbing Piping and Equipment": Product and installation requirements for piping hangers and supports.
 - 3. Section 22 05 48 - "Vibration and Seismic Controls for Plumbing Piping and Equipment": Product and installation requirements for vibration isolators used in piping systems.
 - 4. Section 22 05 53 - "Identification for Plumbing Piping and Equipment."
 - 5. Section 22 07 00 - "Plumbing Insulation"
 - 6. Section 22 05 03 - "Pipes and Tubes for Plumbing Piping and Equipment."
 - 7. Section 22 05 23 - "General Duty valves for Plumbing Piping."
 - 8. Section 22 40 00 - "Plumbing Fixtures."

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

- A. ASME (American Society of Mechanical Engineers)
 - 1. ASME B16.20, "Metallic Gaskets for Pipe Flanges- Ring-Joint, Spiral-Wound, and Jacketed," 2007.
 - 2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
 - 3. ASME B16.21, "Nonmetallic Flay Gaskets for Pipe Flanges," 2005.
 - 4. ASME B31.9, "Building Services Piping," 2004.
- B. AWS (American Welding Society)
 - 1. AWS D1.1, "Structural Welding Code- Steel," 2008.
 - 2. ANSI/AWS B2.1, "Standard Specification for Welding Procedure and Performance Qualification," 2005.
 - 3. ANSI/AWS D10.12, "Guide for Welding Mild Steel Pipe," January, 2000.

- C. AWWA (American Water Works Association)
 - 1. ANSI/AWWA C111, "Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings," 2007.
- D. IMC (International Mechanical Code), 2009
- E. IPC (International Plumbing Code), 2009

1.4 DESIGN REQUIREMENTS

- A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints and adequately protect all systems.

1.5 SUBMITTALS

- A. General: Submit each item in this Section according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints.
- C. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- D. Design Data: Indicate criteria and show calculations. Submit sizing methods and calculations.
- E. Manufacturer's Installation Instructions: Submit special procedures.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
 - 1. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
- B. Maintenance data to be included in the operation and maintenance manual specified in Division 01. Include detailed manufacturer's instructions on servicing, disassembling, and adjusting.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

- B. Perform Work in accordance with all applicable codes and standards.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years experience.
- B. Installer: Company specializing in performing work of this section with minimum 5 years experience.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
- B. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS:

- A. Flexible pipe connectors shall be equal to those manufactured by the Metraflex Corporation and shall be designed for a working pressure of not less than 150 psig with a bursting pressure of not less than 300 psig when handling water at a temperature of 250°F.
- B. The flexible pipe connectors shall be made of a corrosion resistant material, such as bronze or stainless steel with a braided wire cover. Flexible connectors shall be long enough to compensate for the following offset misalignments in piping:

| MAXIMUM PIPE SIZE | MAXIMUM PERMANENT OFFSET | MAXIMUM INTERMITTENT OFFSET |
|----------------------|-----------------------------|--------------------------------|
| 2" and smaller | 3/8" | 1/4" |
| 2 1/2" and larger | 3/8" | 1/8" |

- C. Rubber-Sphere Packless-Type Pipe Expansion Joints as manufactured by Metraflex, Keflex, or Vibration Mountings: Single-sphere type, fabric-reinforced butyl rubber with full-faced integral flanges, external control rods, and internal reinforcing. Include steel retaining rings drilled to match flange bolt holes over entire surface of flanges. Pressure rating is 175 psig (1200 kPa) minimum at 240°F (116° C) minimum.
- D. Rubber-Sphere Packless-Type Pipe Expansion Joints as manufactured by Metraflex, Keflex, or Vibration Mountings: Double-sphere type, fabric-reinforced butyl rubber with full-faced integral flanges, external control rods, and internal reinforcing. Include steel retaining rings drilled to match flange bolt holes over entire surface of flanges. Pressure rating is 175 psig (1200 kPa) minimum at 240°F (116° C) minimum.

2.2 EXPANSION JOINTS

- A. Capability: Absorb 200 percent of maximum piping expansion between anchors.
- B. Packless-type Pipe Expansion Joints:
 - 1. Metal-Bellows Packless-Type Pipe Expansion Joints as manufactured by Adsc0,

Metraflex, or Keflex, Inc.: Pressure rated for 175 psig (1200 kPa) minimum; conform to the standards of Expansion Joint Manufacturers Association, Inc. (EJMA); with end fittings and external tie rods for limiting maximum travel. Features include the following:

- a. Copper Piping Systems: 2-ply phosphor-bronze bellows and brass shrouds.
 - b. Steel Piping Systems: 2-ply stainless-steel bellows and carbon-steel shrouds.
2. Externally Pressurized Expansion Joint: Expansion joints shall be of the packless, externally pressurized type. Pressure rated for 150psi @ 700 F or 300psi @ 700°F. Movement capabilities shall be 4", 6", or 8" axial movement, as required. Shall be of welded construction with multiple ply stainless steel bellows, heavy gauge steel shroud, integral guide rings, and internal liner. System line pressure shall be external to the bellows to minimize squirm. Double end joints shall have anchor base to act as intermediate anchor. All joints shall be provided with drain connection and lifting lug. All materials of construction, pressure ratings, and end fittings shall be appropriate for the application. Guiding and anchoring shall be per EJMA recommendations and guideline. Expansion joints shall be "MetraGator" as manufactured by The Metraflex Company, or an approved equal.
 3. Expansion-Compensator Packless-Type Pipe Expansion Joints as manufactured by Adscos, Metraflex, or Keflex, Inc.: Pressure rated for 60 psig (414 kPa) minimum for low-pressure systems and for 175 psig (1200 kPa) minimum for high-pressure systems. Include 2-ply phosphor bronze bellows, brass shrouds, and end fittings for copper piping systems and 2-ply stainless-steel bellows, carbon-steel shrouds, and end fittings for steel piping systems. Include internal guides, antitorque device, and removable end clip for proper positioning.
 4. Steel Pipe Expansion Compensator: Expansion compensators shall be of the packless, externally pressurized type. Pressure rating of 175psi @ 750°F. Axial movements shall be rated for system compression and system extension. Compensators shall be all welded construction, male pipe thread (HPT) weld end (HPW) or flanged (HPF) end connections. Constructed of multiple ply stainless steel bellows, carbon steel shroud, integral guide rings, and internal liner (threaded compensators to have anti-torque device). System line pressure shall be external to the bellows to minimize squirm. All materials of construction, pressure ratings, and end fittings shall be appropriate for the application. Guiding and anchoring shall be per EJMA recommendations and guidelines. Expansion compensators shall be model "HP2" as manufactured by The Metraflex Company, or an approved equal.
 5. Copper Expansion Compensator: Expansion compensators to be of the packless, externally pressurized type. Pressure rating of 150psi @ 400°F. Axial movements to be rated for system compression and system extension. All welded construction with female copper tube seat ends, multiple ply stainless steel bellows, stainless steel shroud, integral guide rings, and internal liner. System line pressure shall be external to the bellows to minimize squirm. Double end joints shall be constructed of two single units and a coupling. Anchor base may be provided to act as intermediate anchor. All materials of construction and pressure ratings shall be appropriate for the application. Guiding and anchoring shall be of EJMA recommendations and guidelines. Expansion compensators shall be model "HPFF" as manufactured by The Metraflex Company, or an acceptable comparable product.

C. Miscellaneous Materials:

1. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars, black and galvanized.

2. Bolts and Nuts: ASME B18.10, or ASTM A183, steel, hex-head, track bolts and nuts.
 3. Washers: ASTM F844, steel, plain, flat washers.
- D. Powder-Actuated Fasteners: Attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- E. Concrete: Portland-cement mix, 3000 psi (20.7 Mpa):
1. Cement: ASTM C150, Type I.
 2. Fine Aggregate: ASTM C33, sand.
 3. Coarse Aggregate: ASTM C33, crushed gravel.
 4. Water: Potable.
- F. Grout: ASTM C 1107, Grade B, non-shrink, nonmetallic:
1. Characteristics include post-hardening volume-adjusting dry hydraulic-cement-type grout that is non-staining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
 2. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
 3. Water: Potable.
 4. Packaging: Premixed and factory-packaged.
- G. Fernco, XJ Series: Furnish and install in PVC and cast iron drain pipe risers, at every other floor, or as indicated on the contract drawings.

2.3 PIPE ALIGNMENT GUIDES

- A. Systems greater than 70°F operating temperature: Provide Erico (formerly known as Michigan) Model No. 650, or an acceptable comparable product.
- B. Systems less than 70°F operating temperature: Provide Erico (formerly known as Michigan) Model No. 651, or an acceptable comparable product.
- C. Style IV – Pipe Alignment Guide (Spider Type): Primary and intermediate guides shall be of the radial type employing a heavy wall guide cylinder with weld down or bolt down anchor base. A two section guide spider, having 1/8" maximum diametrical clearance with guide cylinder inside diameter, bolted or welded tight to the carrier pipe which slides through the guide cylinder I.D. Cylinder shall be of sufficient size to clear pipe insulation and long enough to prevent over travel of the spider. Pipe alignment guides shall be style "PGIV" as manufactured by The Metraflex Company, or an acceptable comparable product.

2.4 PIPE ANCHORS

- A. Steel Shapes and Plates: ASTM A 36/A 36M.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
- C. Washers: ASTM F 844, steel, plain, flat washers.
- D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application.
 1. Stud: Threaded, zinc-coated carbon steel.

2. Expansion Plug: Zinc-coated steel.
 3. Washer and Nut: Zinc-coated steel.
- E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened Portland cement concrete, and tension and shear capacities appropriate for application.
1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 3. Washer and Nut: Zinc-coated steel.
- F. Concrete: Portland cement mix, 3000 psi minimum. Refer to Division 3 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.
- G. Grout: Refer to Division 23 Section "Common Work Results for Mechanical."

2.5 FLEXIBLE PRE-FABRICATED EXPANSION LOOPS

- A. Metraloop® – Flexible Expansion Loop (thermal applications):
1. Provide flexible expansion loops of size and type noted on drawings. Flexible loops shall consist of two flexible sections of hose and braid, two 90° elbows, and a 180° return assembled in such a way that the piping does not change direction, but maintains its course along a single axis. Flexible loops shall have a factory supplied, center support nut located at the bottom of the 180° return, and a drain/air release plug. Flexible loops shall impart no thrust loads to system support anchors or building structure. Loops shall be installed in a neutral, pre-compressed or pre-extended condition as required for the application. For steam service, loops must be installed with flexible legs horizontal to prevent condensate buildup. Install and guide per manufacturer's recommendations. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings. For natural gas service, connectors shall be A.G.A. certified. Flexible expansion loops shall be "Metraloop®" as manufactured by The Metraflex Company®, Chicago, IL or an acceptable comparable product.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pipe Expansion Joint Installation:
1. Install pipe expansion joints according to manufacturer's written instructions.
 2. Align expansion joints to avoid end-loading and torsional stress.
- B. Fabricated-type Pipe Expansion Compensation Installation:
1. Install pipe expansion loops cold-sprung in tension or compression as required to absorb 50 percent of total compression or tension that will be produced during anticipated change in temperature.
 2. Connect risers to mains with at least 5 pipe fittings including tee in main.
 3. Connect risers to terminal units with at least 4 pipe fittings including tee in riser.
- C. Pipe Alignment Guide Installation:

1. Install pipe alignment guides on piping that adjoins pipe expansion joints.
2. Install pipe alignment guides on piping that adjoins pipe expansion loops.
3. Install pipe alignment guides on piping elsewhere as indicated.
4. Secure pipe alignment guides to building substrate.

D. Pipe Anchor Installation:

1. Install pipe anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9, and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS D1.1.
3. Construct concrete pipe anchors of poured-in-place concrete of dimensions indicated, include embedded fasteners.
4. Where pipe expansion joints are indicated, install pipe guides according to expansion unit manufacturer's written instructions to control movement to compensators.
5. Pipe Anchor Spacings: Where not otherwise indicated, install pipe anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Preset anchors as required to accommodate both expansion and contraction of piping.
6. Use grout to form flat bearing surfaces for pipe expansion joints, pipe alignment guides, and pipe anchors that are installed on or in concrete.

E. Expansion Loops:

1. Fabricate expansion loops as indicated on contract documents, and elsewhere as required for adequate control of thermal expansion of installed piping system(s). Subject loops to cold springing which shall absorb 50% of the total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as required to properly anchor and guide piping in relationship to the expansion loops.

3.2 FIELD QUALITY CONTROL

- A. Certified Manufacturer's Installation Report: Prepare a certified report covering installation of pipe expansion joints, pipe alignment guides, and pipe anchors.

END OF SECTION

SECTION 22 0519

METERS AND GAGES 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. Bimetallic-actuated thermometers.
2. Dial-type pressure gages.
3. Gage attachments.
4. Test-plug kits.

B. Related Sections:

1. Division 21 Section "Facility Fire-Suppression Water-Service Piping" for fire-protection water-service meters outside the building.
2. Division 21 fire-suppression piping Sections for fire-protection pressure gages.
3. Division 22 Section "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
4. Division 22 Section " Domestic Water Piping" for water meters inside the building.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Standard: ASME B40.200.
- B. Case: Liquid-filled type(s); stainless steel.
- C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- E. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

- F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- G. Window: Plain glass or plastic.
- H. Ring: Stainless steel.
- I. Element: Bimetal coil.
- J. Pointer: Dark-colored metal.
- K. Accuracy: Plus or minus 1.5 percent of scale range.

2.2 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - 1. Standard: ASME B40.100.
 - 2. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
 - 3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - 4. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - 5. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: Glass or plastic.
 - 9. Ring: Metal.
 - 10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.3 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- B. Install valve and snubber in piping for each pressure gage for fluids.
- C. Install thermometers in the following locations:
 - 1. Leaving the domestic hot water heater(s).
- D. Install pressure gages in the following locations:
 - 1. After the RPBFP and PRV at the DCW service entrance.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

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, and all sections of Division 22.

1.2 SUMMARY

- A. Section includes:

1. Globe valves
2. Check valves.
3. Ball valves.
4. Butterfly valves.
5. Gate valves.
6. Drain valves.
7. Lubricated plug valves.
8. Valving specialties.
9. Trap priming systems.
10. Multi-purpose valves.

- B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 22 05 00 - "Common Work Results for Plumbing."
2. Section 23 05 14 - "Common Motor Requirements."
3. Section 22 05 29 - "Hangers and Supports for Plumbing and Equipment": Product and installation requirements for pipe hangers and supports.
4. Section 22 05 48 - "Vibration and Seismic Controls for Plumbing Piping and Equipment."
5. Section 22 05 53 - "Identification for Plumbing Piping and Equipment": Product and installation requirements for labeling and identification.
6. Section 22 07 00 - "Plumbing Insulation": Product and installation requirements for insulation for valves.
7. Section 22 07 00 - "Plumbing Insulation": Product and insulation requirements for piping, valving connections.
8. Section 22 10 00 - "Plumbing Pumps."
9. Section 22 05 03 - "Pipes and Tubes for Plumbing and Equipment": Product and installation requirements for piping materials applying to various system types.
10. Section 22 25 01 - "Plumbing Piping System Cleaning and Treatment."
11. Section 22 40 00 - "Plumbing Fixtures."
12. Section 22 31 00 - "Domestic Water Softeners."
13. Section 22 05 93 - "Testing, Adjusting, and Balancing for Plumbing."

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

- A. References listed in this section:

1. AGA (American Gas Association)

2. ANSI (American National Standards Institute)
 - a. ANSI/ASME B16.34, "Valves-Flanged, Threaded, and Welding End,".
 - b. ANSI/API 600, "Bolted Bonnet Steel Gate Valves for Petroleum and Natural Gas Industries,".
3. API (American Petroleum Institute)
 - a. API 6D, "Specification for Pipeline Valves,".
 - b. API 594, "Check Valves: Wafer, Wafer-Lig, and Double Flanged Type,".
 - c. API 598, "Valve Inspection and Testing,".
 - d. API 607, "Fire Test for Soft-Seated Quarter Turn Valves,".
 - e. API 608, "Metal Ball Valves- Flanged and But-Welding Ends,".
 - f. API 609, "Lug- and Wafer-Type Butterfly Valves,".
4. ASME (American Society of Mechanical Engineers)
 - a. ASME A112.14.1, "Back Water Valves,".
 - b. ASME B16.10, "Face to Face and End to End Dimensions of Valves,".
5. ASSE (American Society of Sanitary Engineers)
 - a. ASSE 1013, "Reduced Pressure Principle Backflow Preventors,".
 - b. ASSE 1015, "Double Check Backflow Prevention Assembly,".
6. ASTM (American Society for Testing and Materials)
 - a. ASTM A126, "Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings,".
 - b. ASTM A182, "Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service,".
 - c. ASTM B61, "Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service,".
7. BOCA (Building Officials and Code Administrators)
8. IEEE (Institute of Electrical and Electronics Engineers)
9. NJMC New Jersey Mechanical Code
10. NJPC New Jersey Plumbing Code
11. MSSP (Manufacturers Standards Society of the Valve & Fittings Industry)
 - a. MSSP SP-25, "Standard Marketing System for Valves, Fittings, Flanges and Unions,".
 - b. MSSP SP-45, "Bypass Drain Connections,".
 - c. MSSP SP-55, "Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components".
 - d. MSSP SP-61, "Pressure Testing of Steel Valves".
 - e. MSSP SP-67, "Butterfly Valves,".
 - f. MSSP SP-68, "High-Pressure Butterfly Valves with Offset Design,".
 - g. MSSP SP-70, "Cast Iron Gate Valves Flanged and Threaded Ends,".
 - h. MSSP SP-71, "Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings,".
 - i. MSSP SP-72, "Ball Valves with Flanged Fitting,".
 - j. MSSP SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends,.
 - k. MSSP SP-80, "Bronze Gate, Globe, Angle and Check Valves,".
 - l. MSSP SP-85, "Cast Iron Globe and Angle Valves, Flanged and Threaded Ends,".
 - m. MSSP SP-110, "Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends,".
12. NEC (National Electrical Code)
13. NEMA (National Electrical Manufacturers Association)
14. OSHA (Occupational Safety and Health Administration)
15. PHCC (National Standard Plumbing Code)
16. UL (Underwriters' Laboratories)

1.4 SUBMITTALS

- A. General: Submit each item in this Section according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.
- C. Manufacturer's Installation Instructions: Submit hanging, support methods, and joining procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves.
- B. Maintenance data to be included in the operation and maintenance manual specified in Division 01.

1.6 QUALITY ASSURANCE

- A. Valves shall be provided by the same manufacturer when applicable.
- B. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.
- C. Lead Free:
 - 1. Valves in plumbing systems that are intended to dispense potable water for human consumption, including drinking and cooling, shall be "lead free" containing not more than a weighted average of 0.25% lead with respect to the wetted surfaces.
 - 2. Solder and flux for soldered joints in potable water piping shall be "lead free", containing not more than 0.2% lead.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years experience.
- B. Installer: Company specializing in performing work of this section with minimum 5 years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Prepare for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Set globe and gate valves closed to prevent rattling.
 - 3. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 4. Set butterfly valves closed or slightly open.
 - 5. Block check valves in either closed or open position.

- B. Use the following precautions during storage:
 - 1. Store indoors and maintain temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store off the ground in watertight enclosures.
- C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Do not install valves underground when bedding is wet or frozen.

1.10 SEQUENCING AND SCHEDULING

- A. Notification of Interruption of Service: Provide notification for all utility outages.

1.11 DEFINITIONS

- A. Lead Free:
 - 1. The pipes, pipe fittings, plumbing fittings or fixtures in plumbing systems that are intended to dispense potable water for human consumption, including drinking and cooking, shall be "lead free", containing not more than a weighted average of 0.25% lead with respect to the wetted surfaces.
 - 2. Solder and flux for soldered joints in potable water piping shall be "lead free", containing not more than 0.2% lead.

PART 2 - PRODUCTS

2.1 VALVES - BASIC, COMMON FEATURES

- A. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.
- B. Sizes: Same size as upstream pipe, unless otherwise indicated.
- C. Operators: Use specified operators and handwheels, except provide the following special operator features:
 - 1. Chain-Wheel Operators: For valves 3 inches (DN100) and larger, installed 120 inches or higher above finished floor elevation.
 - 2. Gear-Drive Operators: For valves 8 inches (DN200) and larger. Operator shall be factory installed prior to delivery of job-site.
 - 3. Lever Operators: Ball and butterfly valves 10" and less.
- D. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- E. Threads: ANSI/ASME B1.20.1.
- F. Flanges: ASME B16.1, ASME B16.5, and ASME B16.24.
- G. Hexagonal Threaded Packing Adjustment: All ball valves.
- H. Bypass and Drain Connections: Comply with MSS SP-45.

- I. Memory Stops: Provide memory stops for all "Balancing" valves.

2.2 VALVE APPLICATION SCHEDULE:

A. Domestic Water:

1. Globe Valves:

a. 1/8" through 2":

- 1) Globe valves shall be class 250# WOG, rising stem, threaded bonnet, body with integral seat. The body, bonnet, union nut, disc holder & stem shall be ASTM B584 C89833, cast bronze (1/4" through 3/4" disc holder ASTM B16.) Bronze Disc. Hand wheel shall be Malleable iron. MSS SP-80, Type 2. Basis of Design:
Milwaukee Model: UP502 (Threaded)
Milwaukee Model: UP1502 (Sweat)
Other manufacturers: Hammond, Lunkenhimer

b. 2 1/2" through 10":

- 1) Globe valves shall be class 125# SWP, 200# WOG, rising stem, bolted bonnet. Body, bonnet, & Handwheel shall be ASTM A126, Class B cast iron. Stem & Packing Gland shall be ASTM B16, Brass. Seat Ring, Disc through 3" or disc ring for 4" through 10," yoke bushing, & swivel nut shall be cast ASTM B62, Bronze. 125 Lb. flanged ends. Packing will be Aramid Fiber & Graphite with a Neoprene binder for service up to 550°F, MSS SP-85. Basis of Design:
Milwaukee Model: F-2981
NIBCO F718-B
Other manufacturers: Hammond, Lunkenhimer

2. Check Valves:

a. Horizontal Swing 1/4" through 2":

- 1) Check valves shall be class, 200# WOG, horizontal swing check, body with 5° integral seat. Body, cap, & Disc shall be of ASTM, B584 C89833 cast bronze. (Disc on 1/4" through 3/4" ASTM B16) Lever, retaining ring, and Hinge Pin shall be stainless steel. Plug shall be ATSM B16, Lever, MSS SP-80, Type 3. Basis of Design:
Milwaukee Model: UP509 (Threaded)
Milwaukee Model: UP1509 (Sweat)
NIBCO Model: T413-Y-LF (Threaded)
NIBCO Model: S413-Y-LF (Sweat)

b. Horizontal Swing- 2 1/2" through 24":

- 1) Check valves shall be class 125# SWP, 200# WOG, horizontal swing Check. Body, bonnet, Hanger & disc shall be of ASTM A126, Class B cast iron. Hanger Pin, disc nut, & side plug shall be ASTM B16, Brass. Seat Ring & Disc or disc Face Ring of Cast ASTM B62, Bronze. 125 Lb. flanged ends. bolted bonnet. MSS SP-71, Type 1. Basis of Design:
Milwaukee Model: F-2974
NIBCO Model: F918-B

c. Spring Loaded "Silent" Lift- 3/8" through 2":

- 1) Check valves shall be 250# WOG. ASTM B584 C89833, cast bronze body with integral seat, Tail Piece, & center guided disc holder. ASTM B104, bronze Spring. Buna or PTFE disc ring. Basis of Design:
Milwaukee Valve Figure Number UP548B (Threaded)

Milwaukee Valve Figure Number UP1548T (Sweat)

NIBCO Model: T480-Y-LF (Threaded)

NIBCO Model: S480-Y-LF (Sweat)

Other manufacturers: Hammond, Lunkenhimer

d. Wafer Style "Silent"- 2 1/2" through 10":

- 1) Check valves shall be Wafer style Class 125, 200 PSIG WOG minimum. (2 1/2" through 6" shall be combination ANSI 125 & 250 class valves using ANSI class 125 dimensions) Body shall be of ASTM A126, Class B cast iron. Center guided ASTM B62, cast bronze plug, bushing, & seat ring. Stainless Steel spring and seat ring screws. Basis of Design:

Milwaukee Model: 1400 Series

NIBCO Model: W910-B

Other manufacturers: Hammond, Lunkenhimer

3. Ball Valves:

a. 1/4" through 2":

- 1) Ball valves shall be 600 WOG, ASTM B584 C89833, cast bronze two piece adapter loaded single reduced bore with chrome plated solid ASTM B16, brass tunnel drilled ball, blow-out proof brass stem, RPTFE 15% glass filled seats & thrust washer, PTFE packing, hexagonal threaded packing nut of ASTM B16, brass, Lever handle of Zinc plated steel with vinyl handle grip, MSS SP-110. Fed. Spec. WW-V-35C II, BZ, 3. Basis of Design:

Milwaukee Model: UPBA100 (Threaded)

Milwaukee Model: UPBA150 (Sweat)

NIBCO T/S 685-80-LF

Other manufacturers: Worcester, Hill McCena

b. 3 Piece- 1/4" through 2":

- 1) Ball valves shall be 600# WOG, ASTM B584 C899833, cast bronze three piece, exposed bolt design, full bore, chrome plated solid ASTM B16, brass tunnel drilled ball, blow-out proof brass stem, one piece RPTFE 15% glass filled seat and body seal, 25% glass filled RPTFE thrust washer, PTFE packing, hexagonal threaded packing nut of ASTM B16, brass, Grade 8 Zinc plated steel body bolts & nuts, Lever handle of Zinc plated steel with vinyl handle grip, MSS SP-110. Fed. Spec. WW-V-35C II, BZ, 1. Basis of Design:

Milwaukee Model: UPBA-300-A (Threaded)

Milwaukee Model: UPBA-350-A (Sweat)

NIBCO Model: T595-Y-LF (Threaded)

NIBCO Model: S595-Y-LF (Sweat)

Other manufacturers: Worcester, Hill, McCena

c. 2 1/2" Carbon Steel:

- 1) Ball valves shall be ANSI class 150 Lb., split body, full bore. Body of ASTM A216, grade WCB. Steel solid tunnel drilled & grounded ball, vented from the body cavity to the tunnel of the ball. Spiral wound graphite & 304 SS body seals, Multiple piece PTFE/Graphite packing, Threaded hexagonal packing nut or two bolt packing adjustment, lever operator, RPTFE seats (200 PSI @ 350°F). API 607, Valves must be tested in accordance with ANSI B16.34, API 598, and be compliant with NACE MR0175, ANSI/ASME B16.5, MSS SP-72, API 608. Basis of Design:

Carbon Steel Body:

Milwaukee Model: F20CS150F-02 (lever)

NIBCO Model: F-515-CS-R-66-FS (lever)

- Other manufacturers: Fischer, Hammond
- d. 2 ½" Stainless Steel:
- 1) Ball valves shall be ANSI class 150 Lb., split body, full bore. Body of ASTM A216, grade WCB or ASTM A351, grade CF8M stainless steel solid tunnel drilled & grounded ball, vented from the body cavity to the tunnel of the ball. Spiral wound graphite & 304 SS body seals, Multiple piece PTFE/Graphite packing, Threaded hexagonal packing nut or two bolt packing adjustment, lever operator, RPTFE seats (200 PSI @ 350°F). API 607, four bolt actuator mounting configuration to ISO 5211 standards, Valves must be tested in accordance with ANSI B16.34, API 598, and be compliant with NACE MR0175, ANSI/ASME B16.5, MSS SP-72, API 608. Basis of Design:
Stainless Steel Body:
Milwaukee Model: F20SS150F-02 (lever)
NIBCO Model: F-515-S6-R-66-FS-LL (lever)
Other manufacturers: Worcester, Hill McCena
4. Butterfly Valves:
- a. 3" through 48":
 - 1) Materials & Construction:
 - a) Butterfly valves shall be, Cast Iron ASTM A126, Class B Lug Style Body with through tapped lugs. Valves will be of the Phenolic back cartridge, two-piece stem design, molded lip for "Dead End Service". Elastomer seat will be made of EPDM, ASTM D2000, suitable for continuous operation from B30°F through + 275°F, ASTM B148, Alloy 954 Aluminum Bronze Disc with a Broached Stem to Disc Drive Connection. (14" & larger valves to have a plug & pin stem to disc connection) Upper & Lower Blowout proof stems of ASTM A582, Type 416 Stainless Steel. Buna N "O" Ring stem and Dirt seals, 2"+ extended neck to accommodate insulation. Valves to be "Bubble Tight" up to the maximum rated working pressure in either direction. Valves to be factory tested for "Bubble Tight" shut off in accordance with MSS SP-67, and API 609 standards. Valves are rated for Uni-Directional dead end service 3" through 12" 150 PSIG.
 - 2) Maximum Rated Working Pressure:
 - a) For 3" through 12" valves is 200 PSIG
 - 3) Actuator / Operator:
 - a) For all valves 3" through 6" use a 10 position Lever handle with locking Trigger.
 - b) For all valves 8" through 48" use an Enclosed Manual Self-Locking Worm Gear Operator with Handwheel and Position Indicator. Both types of operators are to be equipped with Travel Stops. Basis of Design:
Milwaukee Model: ML-223-E 3" through 5"
Milwaukee Model: ML-323-E 6" through 24"
NIBCO Model: LD20003 3" through 5"
NIBCO Model: LD20005 6" through 24"
5. Hose End Drain Valves ½" and ¾":
- a. Hose end drain valves shall be class 600# WOG, ASTM B584, cast bronze two piece adapter loaded single reduced bore with chrome plated solid ASTM B16, brass tunnel drilled ball, blow-out proof brass stem, RPTFE 15% glass filled seats & 25% glass filled thrust washer, PTFE

packing, hexagonal threaded packing nut of ASTM B16, brass, Lever handle of Zinc plated steel with vinyl handle grip, ASTM B16, brass tail piece with standard hose end threads, brass bead chain and Zinc die cast cap, MSS SP-110, Fed. Spec. WW-V-35C II, BZ, 3. Basis of Design:
Milwaukee Model: BA-100-H (Threaded)
Milwaukee Model: BA-150-H (Sweat)
NIBCO Model: T585-70-HC (Threaded)
NIBCO Model: S585-70-HC (Sweat)

B. Natural Gas Service

1. Ball Valves:

- a. Forged Brass - ¼" through 2" Ball valves shall be class 600 WOG / 150 SWP, forged brass two piece adapter loaded, full bore, with chrome plated solid ASTM B584, brass tunnel drilled ball, blow-out proof brass stem, PTFE seats, PTFE packing, & Buna-N "O" Ring, hexagonal threaded packing nut, Zinc Plated steel lever handle & nut, AGA and CGA approved, UL/FM, MSS SP-110, WW-V-35C, Type II, Comp. BZ, End A. Basis of Design:

Milwaukee Model: BA-475 B

NIBCO T/S FP600A

Other manufacturers: Worcester, Hills McCena

2. Lubricated Plug Valves: Sizes 2 ½" through 4":

- a. Bodies, plugs and bonnets shall be made from ASTM A126 Class B cast iron. Valves shall be full port design.
- b. Ends of threaded valves shall have taper pipe threads conforming to ANSI B2.1.
- c. End flanges shall be integral with the valve body. Flange drilling and thickness shall conform to ANSI B16.1 for pressure Class 125. Flanges shall be finished in accordance with MSS SP-6.
- d. Face-to-Face dimensions of flanged valves shall conform to ANSI B16.10.
- e. Pressure-Temperature rating shall be per ANSI B16.1 flanges, Class 125.
- f. Valves shall conform to MSS-SP-78, Type IV.
- g. Valves shall conform to ANSI B16.38 (2 ½" through 4").
- h. Provide one wrench operator for each size valve.
- i. Valves 2 ½" – 4" shall carry AGA, CGA, CSA and UL certifications and approvals.

Homestead Model: 602

Other manufacturers: Walworth, Rockwell Norstrom

C. Water Service Drains:

1. Piping Hose Bibbs:

- a. All valves at low points in piping systems used for drain valve duty shall be provided with brass or bronze valve body with threaded end connections, chromium plated ball, brass stem, RPTFE seats, seals and stuffing box ring, adjustable packing gland, valve handle, and three quarter (¾) inch hose connection with cap and chain. All valves shall be as manufactured by Apollo, or Milwaukee. Valve model numbers shall be as listed below:

Apollo - 78-104-01 (¾ x ¾)

Milwaukee - BA100H (¾ x ¾)

NIBCO T/S 585-70-HC

2. Equipment Hose Bibbs:

- a. All valves at low points in piping systems used for drain valve duty shall be provided with brass or bronze valve body with threaded end connections, chromium plated ball, brass stem, RPTFE seats, seals and stuffing box ring, adjustable packing gland, valve handle, and three quarter (3/4") inch hose connection with cap and chain. All valves shall be as manufactured by Apollo, or Milwaukee. Valve model numbers shall be as listed below:
Apollo - 78-104-01
Milwaukee - BA100H
NIBCO T/S 585-70-HC

2.3 VALVING SPECIALTIES

- A. Gas Solenoid Valves: Provide "normally closed" 2-way solenoid valve as manufactured by SIKAI, or equivalent. Valves shall be UL and FM approved and labeled.
- B. Gas Pressure Reducing Valves: Valve shall be Equimeter, Inc. Model No. 243, or an acceptable comparable product with internal relief valve and capacities as indicated on the contract drawings. Size valve and springs to deliver scheduled pressures and gas flows.
- C. Pressure Reducing Valves:
 1. Pressure reducing valves shall be lead free and shall be as manufactured by Cla-Val Watts Regulator, Zurn, Spence, or an acceptable comparable product with single valve capable of full range of system (integral low flow bypass as required).
 2. Domestic Water Systems: Provide Cla-Val Model 90, or equivalent 125 pound, cast iron ASTM A126, Class B, fused epoxy coated inside and outside, stainless steel seat, stainless steel stem, suitable for dead-end service.
- D. Safety Relief Valves:
 1. Provide as manufactured by Watts Regulator, Spence, or an acceptable comparable product.
 2. 125 psig working pressure and 250°F maximum operating temperature; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code.
 3. Valve body shall be cast-iron.
 4. Valve shall have forged copper alloy disc, fully enclosed cadmium plated steel spring with adjustable pressure range and positive shut-off.
 5. Factory set valves to relieve at 10 psi above operating pressure.
- E. Domestic Hot Water Return Balancing Valve:
 1. Provide Circuit Solver auto flow balancing valve: Model CSUAS, or acceptable comparable product as manufactured by ThermOmegaTech Model: CSUAS-XX-120.
 2. Valves shall be designed to allow installing contractor to install balance valve without any setup prior to system start-up.
 3. All valves shall be all SS construction with glass and carbon filled TFE seat rings. Valves shall have differential pressure read-out ports across valve seat area. Read-out ports shall be fitted with internal EPT inserts/check valves. Valve bodies shall have 1/4" NPT tapped drain/purge port. Valves shall ball valves on both inlet and outlets to allow valve to be closed for service and then reopened. All valves shall have included mfg. y-strainer. All valves shall have gpm nameplates to assure specific valve cartridge setting.

4. Valves shall be lead free.
- F. Trap Priming Systems:
1. Pressure Differential Valve Type:
 - a. Trap Primers shall be pressure drop activated and be of all brass construction with ½" male NPT inlet and ½" female NPT discharge. Internal components shall consist of a stainless steel debris screen, brass piston and brass discharge jet. Trap primers shall be installed on fresh cold water lines of 1 ½" diameter or less and shall be located where they will be subject to frequent pressure drops of 5 to 10 psi. Working pressure shall be 20 to 80 psi and valves shall be listed to ASSE 1018.
 - b. Units shall be Precision Plumbing Products P1-500, P2-500, PR-500 or an acceptable comparable product as manufactured by: Jay R. Smith or Souix Chief.
 - c. Model P1-500 and P1-500 LL P Series primer valves shall be capable of serving up to 4 floor drains, utilizing distribution unit models: DU-4/DU-U.
 - d. Model P2-500 and P2-500 LL P Series primer valves shall be capable of serving up to 2 floor drains, utilizing distribution units DU-4/DU-U.
- G. Multi-Purpose Valves:
1. Valves shall be Bell & Gossett Model 3DV or comparable product as manufactured by TACO or Armstrong. With spring loaded check valve feature, isolation/shut off valve feature, and a calibrated balancing valve with nameplate and memory stop/button.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. 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.
- C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION OF VALVES

- A. Valves shall be placed in such manner as to be easily accessible for smooth and easy handwheel operation and packing maintenance.
- B. Install valves in piping where shown and where listed herein:

1. To balance flows in water piping systems.
 2. To isolate all items of equipment.
 3. To isolate branch lines and risers at mains.
 4. To drain low points in piping systems.
 5. To drain pipe risers.
 6. To drain equipment.
- C. Where piping or equipment may be subsequently removed, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.
- D. Valves for equipment and controls shall be installed full size of pipe before reducing size to make equipment connection.
- E. Where there is not interference, gate and globe shut-off valves shall be installed with handwheel up on horizontal runs of pipe to prevent accumulation of foreign matter in working parts of valves. In no case shall the stem be installed below the pipe centerline.
- F. Butterfly valves shall be installed with handle position in the horizontal position: i.e., butterfly pivot point parallel with the floor.
- G. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- H. Install valves in a position to allow full handle movement.
- I. For chain-wheel operators, provide chains to 60 inches (1500 mm) above finished floor elevation.
- J. Installation of Check Valves: Install for proper direction of flow as follows:
1. Swing Check Valves: Horizontal position with hinge pin level.
 2. Lift Check Valve: With stem upright and plumb.
 3. Install check valves on each pump discharge and elsewhere as required to control flow direction.
- K. Install drain valves at low points in mains, risers, branch lines, and everywhere else required to permit drainage of the entire system.
- L. Install shut-off valves on natural gas systems upstream of each pressure regulator. Where two pressure regulators are installed in series in a single line, a manual valve is not required at the second regulator.
- M. Install pump discharge valves with stem in upward position.
- N. Install safety relief valves on domestic water heaters, etc. and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge without valves as shown on drawings or to nearest floor drain if not shown on drawings. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 01 for installation requirements.
- O. Provide balancing valves as shown on drawings and as required to permit complete balancing of all systems.

3.3 INSTALLATION OF THREADED CONNECTIONS

- A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
- B. Align threads at point of assembly.
- C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
- D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.4 INSTALLATION OF FLANGED CONNECTIONS

- A. Align flange surfaces parallel.
- B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.5 INSTALLATION OF VALVING SPECIALTIES SPECIFIC TO WATER SYSTEMS

- A. Install pump discharge valves in horizontal or vertical position with stem in upward position. Allow clearance above stem for check mechanism removal.
- B. Install pressure-regulating and reducing valves with inlet and outlet shutoff valves and balance valve bypass. Install pressure gage on valve outlet and install valved bypass where indicated. Install unions at inlet and outlet connections.
- C. Install hose bibbs with integral or field-installed vacuum breaker.
- D. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of 1/8" inch per foot (1 percent) and connect to floor drain body, trap, or inlet fitting. Adjust valve for proper flow.
- E. Adjusting
 - 1. Adjust operation and correct deficiencies discovered during commissioning.
 - a. Electrical Connections: Power wiring and disconnect switches are specified in Division 26.
 - b. Grounding & Bonding for Electrical Systems: Connect unit components to ground according to the National Electrical Code and Specification Section "Grounding."

3.6 ADJUSTING VALVES

- A. VALVES: Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION

SECTION 22 0529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including the General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other Sections of Division 22.

1.2 SUMMARY

A. General Requirements:

1. Incorporate in construction pipe hangers and supports to manufacturer's recommendations utilizing manufacturer's regular production components, parts, and assemblies.
2. Comply with maximum load ratings with consideration for allowable stresses prescribed by ASME B31.1 or MSS SP-58.
3. Provide support, guides and anchors that do not transmit unacceptable heat and vibration to building structure.
4. Installation of pipe hangers and supports shall be based upon the overall design concept of the piping system. The support system shall provide for an control the free movement of piping including its movement in relation to that connected equipment.
5. Provide for vertical adjustments after installation of supported material and during commissioning, where feasible, to ensure pipe is at design elevation and slope.

B. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Acoustical Sealant
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Firestopping relating to plumbing work.
9. Firestopping accessories.
10. Equipment bases and supports.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 22 05 00 - "Common Work Results for Plumbing".
2. Section 22 05 23 - "General Duty Valves for Plumbing Piping".
3. Section 22 05 16 - "Expansion Fittings and Loops for Plumbing Piping".
4. Section 23 30 00 "Refrigerant Piping".
5. Section 22 07 00 - "Plumbing Insulation".
6. Section 22 05 03 - "Pipes and Tubes for Plumbing Piping and Equipment": Execution requirements for placement of hangers and supports specified by this section.
7. Section 22 05 48 - "Vibration and Seismic Controls for Plumbing Piping and

Equipment”: Product and execution requirements for vibration isolators.

1.3 DEFINITIONS

- A. Terminology used in this Section is defined in Manufacturer’s Standardization Society Specification - 90, “Valve and Fittings Standards,” 2000.

1.4 REFERENCES

(Unless otherwise noted, references apply to “latest editions.”)

- A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

- B. ASTM International:

1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Method for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

- C. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

- D. FM Global:

1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

- E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

- F. Underwriters Laboratories Inc.:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

- G. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

1.5 SUBMITTALS

- A. General: Submit each item in this Section according to the Conditions of the Contract

and Division 01 Specification Sections.

- B. Product data for each type of hanger and support.
- C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support, including loads.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.
- F. Submit following in accordance with Conditions of Contract and Division 01 Specifications:
 - 1. Shop drawings of items.
 - 2. Complete description of products to be supplied including product data, dimensions materials of construction and specifications.
 - 3. Installation instructions for each product.
 - 4. Layout of piping to be isolated including vertical risers showing:
 - a. Support points.
 - b. Weight at support points.
 - 5. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method and location of equipment attachment bolts.
 - 6. Special details at large scale and other necessary information to convey understanding of work.
- G. Submission of samples may be requested for each type of hanger device. After approval, samples shall be returned for installation at job site.

1.6 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code - Steel," 2001.
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. NFPA Compliance: Comply with NFPA 13, "Installation of Sprinkler Systems," 1999, for hangers and supports used as components of fire protection systems.
- D. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70 "Definitions."
 - 1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.
- E. Licensed Operators: Use operators that are licensed by powder-operated tool manufacturers to operate their tools and fasteners.
- F. Supply and install incidental materials needed to meet requirements, even if not

expressly specified or shown on drawings without claim for additional payment.

- G. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- H. Should any rotating equipment cause excessive noise or vibration, rebalance, realign or do other remedial work to reduce noise and vibration levels. Excessive is defined as exceeding manufacturer's specifications for unit in question.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing Work of this section with a minimum of five years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Division 01 Specifications, Section 22 05 00 – Common Work Results for Plumbing and information contained herein for requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 Specifications: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is not in accordance with the manufacturer's installation procedures.
- C. Maintain manufacturer's required temperature before, during, and after installation of firestopping materials for minimum periods of time as required by the manufacturer.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, "Carbon Structural Steel," 2001, steel plates, shapes, and bars, black and galvanized.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, "Track Bolts and Nuts," 2000, steel, hex-head, track bolts and nuts.
- C. Washers: ASTM F 844, "Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use," 2005, steel, plain, flat washers.

- D. Grout: ASTM C 1107, Grade B, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)," 2001, non-shrink, nonmetallic.
 - 1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is non-staining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5MPa), 28-day compressive strength.
 - 3. Water: Potable.
 - 4. Packaging: Premixed and factory-packaged.

2.2 PIPE HANGERS AND SUPPORTS

- A. Hangers, Supports, and Components: Provide factory-fabricated products as manufactured by B-Line, AITT Grinnel, Pipe Shields, Inc., or Michigan Hanger. Basis of Design shall be B-Line.
 - 1. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
 - 2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Thermal-Hanger Shield Inserts: 100-psi (690kPa) average compressive strength, waterproofed calcium silicate or treated lumber inserts, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.
- D. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.
- E. Upper attachments to structures shall have an allowable load not exceeding 3 of the failure (proof test) load but are not limited to the specific methods indicated.
- F. Horizontal Non-Insulated Waste, Vent and Storm Water Piping Hangers:
 - 1. Two inch and smaller: Figure No. B3170.
 - 2. Two and one-half inch and larger: Figure No. B3100.
- G. Horizontal Non-Insulated Copper Piping Hangers:
 - 1. Two inch and smaller: Figure No. B3104 CTC.
 - 2. Two and one-half inch and larger: Figure No. B3104 CT.
- H. Insulated Horizontal Piping Hangers: Cold and Hot Water (Domestic)
 - 1. Two inch and smaller: Figure No. B3108 with metal shield, Figure No. B3151.
 - 2. Two and one-half inch and larger: Figure No. B3108 with metal shield, Figure No. B3151.
- I. Vertical Piping Riser Clamps:

1. Copper Pipe: Figure No. B3373CT.
 2. Steel Pipe: Figure No. B3136 and B3137.
- J. PVC and CPVC Piping:
1. Figure No. B3106 with No. B3106V channel, plastic-coated.
 2. For piping 1 inch and smaller, use continuous support system only.
- K. Hangers for Brass Piping or to Eliminate Electrolytic Action:
1. Figure No. B3104C.
- L. Beam Clamps and Attachments:
1. For bolt-on locations to structure, Figure Nos. B3291, B3036, or B3050.
 2. Welded beam attachments, Figure No. B3083.
- M. Concrete Inserts:
1. For concrete spot inserts at single locations for casting into structure, Figure No. B3014 for pre-determined rod size and Figure No. B2500 for universal use.
 2. For continuous slot concrete insert at multi-locations for casting into structure, Figure No. B2505.
- N. Brackets:
1. For equipment and piping adjacent to walls or steel columns, Figure Nos. B3066, B3063 and B3067 depending on weight to be supported.
- O. Pipe Rests:
1. For pipes close to floor where no expansion provision is required, Figure No. B3088T base stand with B3093 adjustable pipe saddle support.
- P. Hanger Rods:
1. Hanger rod, Figure No. B3205.
 2. Continuous threaded rod, Figure No. ATR.
 3. Eye rods, Figure No. B3210 or B3211, depending on load supported.
- Q. Trapeze Hangers - Direct Mounting Hangers:
1. Grinnell, Figure No. 46.
- R. Protection Saddles:
1. Cast iron pipe, insulated, Figure No. B3108 with metal shield, Figure No. B3151.
 2. For high temperature steel pipe, insulated, No. B3160, B3161, B3162, B3163, B3164, or B3165.
- S. Pipe Roll Stands:
1. For support of pipe where axial movement is encountered: Figure No. B3117SL where no vertical adjustment is required; and Figure No. B3118SL where vertical adjustment is required.

T. Horizontal AWWA Piping (Flanged or Bell-spigot) Hangers:

1. Cast iron pipe, Figure No. B3102.

2.3 ACOUSTICAL SEALANT

A. Sealants for acoustical purposes shall be one of following non-setting sealants:

Acoustical sealantD.A.P.
BR – 96Pecra
Acoustical sealant.....Tremco
Acoustical sealant.....U.S.G.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material. Install damming materials to arrest liquid material leakage.
- B. Remove incompatible materials affecting bond.
- C. Drilling or cutting of structural members shall be as detailed / directed by structural engineer.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Comply with MSS SP-69, "Pipe Hangers and Supports C Selection and Application," 1996, and SP-89, "Pipe Hangers and Supports -- Fabrication and Installation Practices," 1998. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. Piping shall be supported independently from equipment connections. Supports shall not interfere with removal of equipment.
- B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.
- C. Install supports with maximum spacings complying with MSS SP-69, "Pipe Hangers and Supports C Selection and Application," 1996, and as specified in Section 22 05 03 - "Pipes and Tubes for Plumbing Piping and Equipment."
- D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
- E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69, "Pipe Hangers and Supports C Selection and Application," 1996. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts in new construction prior to placing concrete. Install reinforcing bars through openings at top of inserts.
- F. Install powder-actuated drive-pin fasteners 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. Do not use in lightweight concrete slabs or in concrete slabs less than

4 inches (100 mm) thick.

- G. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100 mm) thick.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36, "Carbon Structural Steel," 2001, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1, "Structural Welding Code - Steel," 2001.
- J. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
- M. Insulated Piping: Provide continuous insulation and vapor barrier through hangers and supports. Comply with the following installation requirements.
 - 1. Riser Clamps: Attach riser clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9. Insulate clamps on piping with insulation and vapor barrier.
 - 2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
 - 3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees (3.1 rad) and have dimensions in inches (mm) not less than the following:

| NPS (Inches) | LENGTH (Inches) | THICKNESS (Inches) |
|--------------|-----------------|--------------------|
| 1/4 to 3 1/2 | 12 | 0.048 |
| 4 | 12 | 0.060 |
| 5 and 6 | 18 | 0.060 |
| 8 to 14 | 24 | 0.075 |
| 16 to 24 | 24 | 0.105 |

- 4. Pipes 4 Inches (200 mm) and Larger: Include treated wood inserts.
- 5. Insert Material: Length to equal to the length of the protective shield.

- N. Conform to the table below for maximum spacing of supports and rod sizes:

- 1. Steel and Copper Pipe:

| Nom. Pipe Size – In. | Steel Pipe Max. Span – Ft. | Copper Tube Max. Span – Ft. | Min. Rod Dia. – In. |
|----------------------|----------------------------|-----------------------------|---------------------|
| Up to 3/4 | 7 | 5 | 3/8 |
| 1 | 7 | 6 | 3/8 |
| 1 1/4 | 7 | 7 | 3/8 |

| Nom. Pipe Size – In. | Steel Pipe Max. Span – Ft. | Copper Tube Max. Span – Ft. | Min. Rod Dia. – In. |
|----------------------|----------------------------|-----------------------------|----------------------|
| 1 1/2 | 9 | 8 | 3/8 |
| 2 | 10 | 8 | 3/8 |
| 2 1/2 | 11 | 9 | 1/2 |
| 3 | 12 | 10 | 1/2 |
| 3 1/2 | 12 | 11 | 1/2 |
| 4 | 12 | 12 | 5/8 (1/2 for copper) |
| 5 | 12 | 12 | 5/8 (1/2 for copper) |
| 6 | 12 | 12 | 3/4 (5/8 for copper) |

a. Support vertical steel pipe and copper tube at each floor.

2. Pex Piping

| Horizontal In Inches | Vertical In Feet |
|----------------------|------------------|
| 32 | 10 |

a. A guide shall be installed midway between required vertical supports. Guides shall prevent pipe movement in a direction perpendicular to the axis of the pipe

3. Polypropylene

| Pipe Size – in. | Horizontal In Inches | Vertical In Feet |
|-----------------|----------------------|------------------|
| Up to 1 | 32 | 10 |
| 1 1/4 and up | 48 | 10 |

a. A guide shall be installed midway between required vertical supports. Guides shall prevent pipe movement in a direction perpendicular to the axis of the pipe

4. Drain Piping:

| Pipe Material | Horizontal In Feet | Vertical In Feet |
|---------------------|--------------------|------------------|
| Cast-Iron Soil Pipe | 5 | 15 |
| PVC Plastic Pipe | 4 | 4 |

- a. Support plastic pipe and tubing in accordance with manufacturer's recommendations.
- b. Support cast-iron piping at each hub.

O. Equipment Supports:

- 1. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- 2. Grouting: Place grout under supports for equipment and concrete bases. Make a smooth bearing surface.

P. Metal Fabrication:

- 1. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.
- 2. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- 3. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:
 - a. Use materials and methods that minimize distortion and develop strength

- and corrosion resistance of base metals.
- b. Obtain fusion without undercut or overlap.
- c. Remove welding flux immediately.
- d. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

Q. Painting:

1. Touching Up: Clean field welds and abraded areas of factory paint and paint exposed areas immediately after erection of hangers and supports. Use same materials as used for factory painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
2. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of factory paint on miscellaneous metal is specified in Division 9 Section "Painting."
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

R. Field Quality Control

1. Licensed Engineer's Report: Prepare hanger and support installation report. Include seal and signature of Registered Engineer, licensed in jurisdiction where Project is located, certifying compliance with specifications.

3.3 APPLICATIONS FOR HANGER AND SUPPORT

- A. Specific hanger requirements are specified in the Section specifying the equipment and systems.
- B. Comply with MSS SP-69, "Pipe Hangers and Supports C Selection and Application," 1996, for pipe hanger selections and applications that are not specified in piping specification Sections.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3 ½" thick and extending 4" beyond supported equipment.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 22 05 48 - "Vibration and Seismic Controls for Plumbing and Equipment."

3.5 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24

inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor drains and floor sinks watertight to adjacent materials.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 FIELD QUALITY CONTROL

- A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.7 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.8 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Adjust for pipe alignment and final equipment connections. Flexible connections shall not be used for adjustment of alignment.

END OF SECTION

SECTION 22 0533

HEAT TRACING 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. This Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

- 1. Self-regulating, parallel resistance.

- B. Related Sections include the following:

- 1. Division 21 Section "Heat Tracing for Fire-Suppression Piping."
 - 2. Division 23 Section "Heat Tracing for HVAC Piping."

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

- 1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

- B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.

- 1. Wiring Diagrams: Power, signal, and control wiring.

- C. Field quality-control test reports.

- D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

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.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Heating Element: Pair of parallel No. 16 AWG, tinned stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled non-

heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

- B. Electrical Insulating Jacket: Flame-retardant polyolefin.
- C. Maximum Operating Temperature (Power On): 150 deg F
- D. Maximum Exposure Temperature (Power Off): 185 deg F.
- E. Maximum Operating Temperature: 300 deg F.

2.2 CONTROLS

- A. Pipe-Mounting Thermostats for Freeze Protection:
 - 1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F .
 - 2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
 - 3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
 - 4. Corrosion-resistant, waterproof control enclosure.
- B. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters:
 - 1. Automatic control with manual on, automatic, and standby/reset switch.
 - 2. Precipitation and temperature sensors shall sense the surface conditions of roof and gutters and shall be programmed to energize the cable as follows:
 - a. Temperature Span: 34 to 44 deg F .
 - b. Adjustable Delay Off Span: 30 to 90 minutes.
 - c. Energize Cables: Following two minute delay if ambient temperature is below set point and precipitation is detected.
 - d. De-Energize Cables: On detection of a dry surface plus time delay.
 - 3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
 - 4. Minimum 30-A contactor to energize cable or close other contactors.
 - 5. Precipitation sensor shall be freestanding.
 - 6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control system workstation.

2.3 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Labels: Refer to Division 22 Section "Identification for Plumbing Piping and Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Install the following types of electric heating cable for the applications described:
 1. Snow and Ice Melting on Roofs and in Gutters and Downspouts: Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

- A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written recommendations using cable protection conduit and slack cable to allow movement without damage to cable.
- B. Electric Heating Cable Installation for Freeze Protection for Piping:
 1. Install electric heating cables after piping has been tested and before insulation is installed.
 2. Install electric heating cables according to IEEE 515.1.
 3. Install insulation over piping with electric cables according to Division 22 Section "Plumbing Insulation."
 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- C. Set field-adjustable switches and circuit-breaker trip ranges.
- D. Protect installed heating cables, including non-heating leads, from damage.

3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 1. Test cables for electrical continuity and insulation integrity before energizing.
 2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.
- C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 22 0548

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including the General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other Sections of Division 22.

1.2 SUMMARY

- A. This Section includes vibration isolators for plumbing systems piping and equipment.
- B. Section includes:
 - 1. Materials.
 - 2. Vibration Isolation Mount types.
 - 3. Equipment bases.
 - 4. Resilient Penetration sleeve/seal.
 - 5. Flexible electrical connections.
 - 6. Restraints.
 - 7. Grommets.
 - 8. Acoustical sealant.
 - 9. Vibration isolation schedule.
- C. Related Sections:
 - 1. Section 22 05 00 - "Common Work Results for Plumbing."
 - 2. Section 22 07 00 - "Plumbing Insulation."
 - 3. Section 22 05 03 - "Pipes and Tubes for Plumbing Piping and Equipment."
 - 4. Section 22 05 16 - "Expansion Fittings and Loops for Plumbing Piping": Product requirements for anchors and piping expansion compensation.
 - 5. Section 22 05 29 - "Hangers and Supports for Plumbing Piping and Equipment": Product requirements for pipe hangers and supports.

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

- A. American National Standards Institute:
 - 1. ANSI S1.4 - Sound Level Meters.
 - 2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
 - 3. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.
- B. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.
- C. American Society of Heating, Refrigerating and:
 - 1. ASHRAE Handbook - HVAC Applications.

1.4 DEFINITIONS

- A. Terminology used in this Section is defined in Manufacturer's Standardization Society Specification 90, "Valve and Fittings Standards," 2000.
- B. Life Safety Systems:
 - 1. All systems involved with fire protection including sprinkler piping, and service water supply piping systems.
 - 2. All plumbing systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flowpaths to fire protection.
- C. Positive Attachment:
 - 1. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure.
- D. Transverse Bracing:
 - 1. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe.
- E. Longitudinal Bracing:
 - 1. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

1.5 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the contract and Division 01 Specification Sections.
- B. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- C. Shop drawings for each type of isolator, indicating dimensions, weights, required clearances, and methods of component assembly.
- D. Submit following in accordance with Conditions of Contract and Division 1 Specifications:
 - 1. Shop drawings of items.
 - 2. Complete description of products to be supplied including product data, dimensions materials of construction and specifications.
 - 3. Installation instructions for each product.
 - 4. Tabulation showing for each vibration isolator supporting equipment:
 - a. Equipment identification tag no.
 - b. Isolator type.
 - c. Actual load.
 - d. Static deflection expected under actual load.
 - e. Specified minimum static deflection.
 - f. Additional deflection to solid under actual load.
 - g. Ratio of spring height under actual load to spring diameter.

5. Layout of piping to be isolated including vertical risers showing:
 - a. Support points.
 - b. Weight at support points.
 - c. Isolator type.
 - d. Static deflection expected under actual load.
 - e. Specified static deflection.
 - f. Additional deflection to solid under actual load.
 - g. Ratio of spring height under load to spring diameter.
 6. Special details at large scale and other necessary information to convey understanding of work.
- E. Submission of samples may be requested for each type of vibration isolation device. After approval, samples shall be returned for installation at job site.

1.6 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code - Steel," 2001.
 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. Manufacturer of vibration isolation control equipment shall have the following responsibilities:
 1. Determine vibration isolation restraint sizes and locations.
 2. Provide calculations and materials if required for restraint of un-insulated equipment.
 3. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
- D. Licensed Operators: Use operators that are licensed by power operated tool manufacturers to operate their tools and fasteners.
- E. Coordinate size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- F. Provide vibration isolators of appropriate sizes and proper loading to meet specified deflection requirements.
- G. Supply and install incidental materials needed to meet requirements, even if not expressly specified or shown on drawings without claim for additional payment.
- H. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- I. Should any rotating equipment cause excessive noise or vibration, rebalance, realign or do other remedial work to reduce noise and vibration levels. Excessive is defined as exceeding manufacturer's specifications for unit in question.
- J. Speed And Balance Requirements For Rotating Equipment:

1. Pumps and other rotating mechanical equipment shall not operate at speeds in excess of 80% of their critical speed.
2. Vertical vibration of rotating equipment shall not be greater than levels indicated elsewhere. Measure vibration on equipment or steel frame equipment base when equipment is mounted on its vibration isolation mounts. If equipment has inertia base, allowable vibration level is reduced by ratio of equipment weight alone to equipment weight plus inertia base weight.

| Equipment Speed (rpm) | Vibration Displacement (mils, peak-to-peak) |
|--------------------------|--|
| Under 600 | 4 |
| 600 to 1000 | 3 |
| 1000 to 2000 | 2 |
| over 2000 | 1 |

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, "Carbon Structural Steel," 2001, steel plates, shapes, and bars, black and galvanized.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, "Track Bolts and Nuts," 2000, steel, hex-head, track bolts and nuts.
- C. Washers: ASTM F 844, "Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use," steel, plain, flat washers.
- D. Grout: ASTM C 1107, Grade B, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)," non-shrink, nonmetallic.
 1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is non-staining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
 2. Design Mix: 5000-psi (34.5MPa), 28-day compressive strength.
 3. Water: Potable.
 4. Packaging: Premixed and factory-packaged.

2.2 VIBRATION ISOLATION MOUNT TYPES

- A. General
 1. Metal parts of vibration isolation units installed out-of-doors shall be hot-dip galvanized, cadmium-plated or Neoprene-coated after fabrication. Galvanizing

- shall meet ASTM 144 "Salt Spray Test Standards and Federal Test Standard."
2. Isolator types are scheduled to establish minimum standards. Optionally, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories shall not degrade vibration isolation system.

B. Unit NP (Neoprene Pad)

1. Two layers of 3/4" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required. Pads shall be Model RSP as manufactured by Kinetics Noise Control or type Super "W" as manufactured by Mason Industries, Inc., or comparable acceptable product.

C. Unit HSN (Hanger Spring and Neoprene) (Type 3)

1. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene or pre-compressed elastomer coated fiberglass elements at the top and a steel spring with general characteristics as in specification 5 seated in an optional steel washer reinforced neoprene cup on the bottom. The neoprene element and the optional cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree E arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30 degree E capability. Hangers shall be Model SRH or SFH as manufactured by Kinetics Noise Control or type 30N as manufactured by Mason Industries, Inc., or comparable acceptable product.

2.3 RESILIENT PENETRATION SLEEVE/SEAL

A. Unit RPS-A (Resilient Penetration Sleeve/Seal)

1. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc., or comparable acceptable product.

2.4 FLEXIBLE ELECTRICAL CONNECTION

A. Unit FEC-A (Flexible Electrical Connection Type A):

1. Flexible electrical coupling shall be prefabricated units incorporating flexible watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wire way and end hubs with standard tapered electrical threads to fit standard threaded, rigid metal conduit.
2. Unit FEC-A shall be as specified in section "Raceways and Boxes for Electrical

Systems” for liquid tight flexible metal conduit.

- B. Unit FEC-B (Flexible Electrical Connection Type B):
 - 1. Flexible electrical couplings shall be field-fabricated using minimum 2 ft length of flexible conduit or cable installed in grossly slack "U" shape.
 - 2. Unite FEC-B shall be as specified in section “Raceways and Boxes for Electrical Systems” for flexible metal conduit.

2.5 RESTRAINTS

- A. Thrust Restraint
 - 1. Thrust restraints shall consist of spring element in series with Neoprene pad.
 - 2. Thrust restraint shall be designed to have same deflection as specified for isolators supporting equipment generating thrust.
 - 3. Spring element shall be contained within steel frame and be designed to be factory-preset for thrust and be field-adjustable to allow for maximum of 1/4" movement during starting or stopping of equipment.
 - 4. Furnish assembly complete with rods and angle brackets for attachment to both equipment generating thrust and adjacent fixed structural anchor.
 - 5. Thrust restraint shall be Model HSR as manufactured by Kinetics Noise Control or Mason Industries Type WB, or comparable acceptable product.

2.6 GROMMETS

- A. Grommets shall be either custom made by combining Neoprene washer and sleeve, or be Isogrommets as manufactured by MBIS, Inc., or be Series W by Barry Controls.
- B. Neoprene shall be between 40 and 50 durometer.
- C. Grommets shall be specially formed to prevent fastening bolts from directly contacting isolator base plate.

2.7 ACOUSTICAL SEALANT

- A. Sealants for acoustical purposes shall be one of following non-setting sealants:
 - Acoustical sealant D.A.P.
 - BR-96 Pecra
 - Acoustical sealant Tremco
 - Acoustical sealant U.S.G.

2.8 VIBRATION ISOLATION SCHEDULE

| | | | Slab on Grade | | | Up to 30 Ft. Floor Span | | | Greater Than 30' Floor Span | | | |
|--------|------------------|-----|---------------|---------------|-------------------------|-------------------------|---------------|-------------------------|-----------------------------|---------------|-------------------------|-----------------------------|
| Pumps | Horsepower/Other | RPM | Base Type | Isolator Type | Minimum Deflection, IN. | Base Type | Isolator Type | Minimum Deflection, IN. | Base Type | Isolator Type | Minimum Deflection, IN. | Component Importance Factor |
| Inline | All | All | A | 3 | 0.75 | A | 3 | 1.50 | A | 3 | 1.50 | |

PART 3 - EXECUTION

3.1 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General

1. Locations of vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with manufacturer's written instructions.

B. Isolation Mounts

1. Squarely align vibration isolators above or below mounting points of supported equipment.
2. Isolators for equipment with bases shall be located on sides of bases, which are parallel to equipment shaft unless this is not possible because of physical constraints.
3. If housekeeping pad is provided, isolators shall bear on housekeeping pad and isolator base plate shall rest entirely on pad. Maintain at least ten bolt diameters from isolator anchors to edge of pad.
4. Hanger rods for vibration isolated support shall be connected to structural beams or joists; not from floor slab between beams and joists. Provide intermediate support members as necessary.
5. Position vibration isolation hanger elements as high as possible in hanger rod assembly but not in contact with building structure, and so that hanger housing may rotate full 360 degrees about rod axis without contacting any object.
6. Parallel-running pipes may be hung together on trapeze, which is isolated from building. Isolator deflections must be largest determined by provisions for pipe isolation. Do not mix isolated and non-isolated pipes on same trapeze.
7. No pipes or equipment shall be supported from other pipes or equipment.
8. Resiliently-isolated pipes shall not contact rigid building structure or equipment.
9. Installed and operating heights of vibration-isolated equipment mounted on Unit FSN isolators shall be identical. Limit stops shall be out of contact during normal operation.
10. Adjust leveling bolts and hanger rod bolts so isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases

1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by equipment manufacturer. This provision shall apply whether or not base frame is specified or indicated on drawings. If base frame is required for unit because of equipment manufacturer's requirements and is not specifically called for, base frame recommended by equipment manufacturer shall be provided at no additional expense.
2. Unless otherwise indicated, provide minimum operating clearance of 1.5" between inertia bases or structural steel frames and concrete housekeeping pad on floor beneath equipment. Position isolator mounting brackets so that required clearance is maintained. Check clearance space to ensure that no construction debris has been left to short-circuit or restrict proper operation of vibration isolation system.

D. Thrust Restraints

1. Attach thrust restraints at centerline of thrust and symmetrically on each side of equipment generating thrust.
2. Adjust restraints to limit equipment movement to specified limit.

E. Resilient Penetration Sleeve/Seals

1. Penetration seals shall maintain airtight seal around penetrating element and shall prevent contact of penetrating element and building structure. Fit sleeve tightly to building construction and with acoustical sealant seal airtight on both sides of construction penetrated.

3.2 APPLICATIONS FOR VIBRATION CONTROLS

A. Major Equipment

1. Unless otherwise shown or specified, major floor-mounted equipment shall be set on housekeeping type concrete pads. See architectural or structural drawings for details.
2. Thrust Restraints shall be installed on equipment as called for in schedule on drawings or specified hereunder.
3. Electrical connections to vibration-isolated equipment exposed to weather shall be Unit FEC-A.
4. Electrical connections to vibration-isolated equipment located indoors shall be Unit FEC-B.

B. Pipes

1. Isolators for first three support points adjacent to connected equipment shall achieve half of specified static deflection of isolators supporting connected equipment. When required static deflection of these pipe isolators is greater than 0.50," Unit FSN or HSN isolators, (whichever is applicable for mounting condition) shall be used.
2. Where lateral support of pipe risers is required within specified limits, use resilient lateral supports.
3. Pipes within specified limits that penetrate building construction shall be isolated from building structure by (Unit RPS-A or Unit RPS-B) resilient penetrating sleeve/seals.
4. Drain piping connected to vibration-isolated equipment shall not contact building structure or other non-isolated system unless it is resiliently mounted as described above.

3.3 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Adjust for pipe alignment and final equipment connections. Flexible connections shall not be used for adjustment of alignment.

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, and all sections of Division 22.

1.2 SUMMARY

- A. Section Includes:
 - 1. Painted Identification Materials.
 - 2. Plastic Pipe Markers.
 - 3. Underground-Type Plastic Line Marker.
 - 4. Valve Tags.
 - 5. Valve Schedule Frames.
 - 6. Engraved Plastic-Laminate Signs.
 - 7. Plastic Equipment Markers.
 - 8. Plasticized Tags.
- B. Related Sections The following Sections contain requirements that relate to this Section:
 - 1. Section 22 05 00 - "Common Work Results for Plumbing."
 - 2. Section 22 10 00 - "Plumbing Pumps."
 - 3. Section 22 05 03 - "Pipes and Tubes for Plumbing Piping and Equipment."
 - 4. Section 22 05 23 - "General Duty Valves for Plumbing Piping."
 - 5. Section 22 40 00 - "Plumbing Fixtures."

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

- A. American Society of Mechanical Engineers:
 - 1. ASME A13.1 - Scheme for the Identification of Piping Systems, 2007.
- B. National Fire Protection Association:
 - 1. NFPA 99 - Standard for Health Care Facilities, 2005.

1.4 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.
- B. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- C. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

- D. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8 1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. Furnish copies for Maintenance Manuals as specified in the Division 01 Specifications.
- E. Maintenance Data: Include product data and schedules in maintenance manuals, in accordance with requirements of Division 01.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1, for lettering size, length of color field, colors, and viewing angles of identification devices.
- C. Equipment Lettering and Graphics:
 - 1. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.
 - a. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification, which indicates individual system number as well as service (for example; Water Heater No. 3).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering identification materials which may be incorporated in the work include, but are not limited to, the following:
- B. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:
 - 1. Brady (W.H.) Co.; Signmark Div.
 - 2. Industrial Safety Supply Co., Inc.
 - 3. Seton Name Plate Corp.

2.2 MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.
- B. Painted Identification Materials:

1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes not less than 1 1/4" high for ductwork and not less than 3/4" high for access door signs and similar operational instructions. Stencils shall not be utilized on piping and plumbing equipment.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
3. Identification Paint and Background Color; Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems and plumbing equipment comply with ANSI A13.1 for colors.

C. Plastic Pipe Markers:

1. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, UV-resistant color-coded pipe markers, complying with ANSI/ASME A13.1
2. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - b. Adhesive lap joint in pipe marker overlap.
 - c. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1 1/2".
3. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - a. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 - b. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
4. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
 - a. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
5. Provide pipe markers with the following background colors and designations:

| SERVICE | STENCIL DESIGNATION | LETTER COLOR | BACKGROUND COLOR |
|---------------------------|---------------------------|--------------|------------------|
| Sanitary/Vent | Sanitary Sewer/Vent | White | Safety Green |
| Domestic Cold Water | Domestic Cold Water | White | Safety Green |
| Domestic Hot Water | Domestic Hot Water | Black | Safety Green |
| Domestic Hot Water Return | Domestic Hot Water Return | Black | Safety Green |
| Condensate Drain | Drain Water | White | Safety Green |
| Natural Gas | Natural Gas (psig) | Black | Safety Yellow |

D. Underground-type Plastic Line Marker:

1. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of buried pipe.
 - a. Provide multi-ply tape consisting of solid aluminum foil core between

2-layers of plastic tape.

E. Valve Tags:

1. Plastic Laminate Valve Tags: Provide manufacturer's standard 3/32" thick engraved plastic laminate valve tags, with piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
 - a. Provide 1 1/2" sq. black tags with white lettering, except as otherwise indicated.
 - b. Provide size, shape and color combination as specified or scheduled for each piping system.
2. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16" high letters and sequenced valve numbers approximately 3/8" high, and with 5/32" hole for fastener.
 - a. Provide 1 1/8" sq. white tags with black lettering.
 - b. Provide size, shape and color combination as specified or scheduled for each piping system.
3. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
4. Ceiling Grid and Access Panel Markers: Provide Kroy type clear adhesive printed labels with 3/16" high letters to identify the type of concealed plumbing devices.

F. Engraved Plastic-laminate Signs:

1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/8", except as otherwise indicated.
3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
4. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
5. Size: Provide approximate 2 1/2" x 4" markers for control devices, dampers, and valves; and 4 1/2" x 6" for equipment.

G. Plasticized Tags:

1. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3 1/4" x 5 5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. General:

1. Coordination: Where identification is to be applied to surfaces, which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
2. Confined Spaces: Provide labels and signs on all duct and equipment doors, plenums, etc. to indicate service and provide operator warnings as required by OSHA, NFPA, and authority having jurisdiction.

B. Piping System Identification:

1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - a. Plastic pipe markers, with application system as indicated under "Materials" in this section.
2. Locate pipe markers and color bands as follows on all piping in occupied spaces, above ceilings, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - a. Near each valve and control device.
 - b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ ceilings, or enter non-accessible enclosures.
 - d. At access doors, manholes and similar access points, which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced intermediately at maximum spacing of 25' along each piping run, except reduce spacing to 10' in congested areas.

C. Underground Piping Identification:

1. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

D. Valve Identification:

1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures. List each tagged valve in valve schedule for

each piping system.

E. Equipment Identification:

1. General: Install engraved plastic laminate sign on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Water meters and flow meters.
 - c. Fuel-burning units.
 - d. Pumps, compressors, and similar motor- driven units.
 - e. Heat exchangers, expansion tanks, and similar equipment.
 - f. Tanks and pressure vessels.
 - g. Filters, water treatment systems and similar equipment.
 - h. Domestic water heater, etc.
2. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.
3. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety precautions, and warn of hazards and improper operations.

3.3 ADJUSTING

- A. Adjusting: Relocate any identification device, which has become visually blocked by work of this division or other divisions.

3.4 CLEANING

- A. Cleaning: Clean face of identification devices.

3.5 EXTRA STOCK

- A. Furnish minimum of 5% extra stock of each identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION

SECTION 22 0593

TESTING, ADJUSTING AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including the General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other Sections of Division 22.

1.2 SUMMARY

- A. Coordinate work of this section with all trades.
- B. Work covered in this Section shall be performed after completion of work specified in all Divisions as they related to this work.
- C. Review of design drawings and specifications, and comment on potential problem areas.
- D. Site inspections of ongoing sheet metal installation with written report from each visit.
- E. Measurement and setting of all domestic hot water systems provided or specified in accordance with these contract documents, recording data, making tests, and preparing reports, all as hereinafter specified.
- F. Coordinate with all trades to provide all incidental items not indicated on drawings or in specifications that belong to work described or are required for complete systems balancing, at no additional cost to Owner.
- G. Refer to paragraph "Closeout Submittals" in Section 22 05 00 - "Common Work Results for Plumbing."

1.3 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.
- B. Agency Data:
 - 1. Submit proof that proposed testing, adjusting, and balancing agency meets the qualifications specified within 30 days of award of contract.
- C. Engineer and Technicians Data:
 - 1. Submit proof that Test and Balance Engineer assigned to supervise procedures, and technicians proposed to perform procedures meet qualifications specified within 30 days of award of contract.
- D. Procedures and Agenda: Submit synopsis of testing, adjusting, and balancing procedures and agenda proposed to be used for this project within 90 days of award of contract.

- E. Document Review:
1. Submit certification in writing that all design drawings and specifications have been reviewed, and comment on potential problems within 90 days of award of contract.
- F. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems. Include this information in maintenance data specified in Division 01 and Section 22 05 00 - "Common Work Results for Plumbing."
- G. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of Test and Balance Engineer. Reports shall be certified proof that systems have been tested, adjusted, and balanced in accordance with referenced standards; are an accurate representation of how systems have been installed; are true representation of how systems are operating at completion of testing, adjusting, and balancing procedures; and are accurate record of final quantities measured, to establish normal operating values of the systems. Follow procedures and format specified below:
1. Report Format: Report forms shall be those standard forms prepared by referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with project identification and a title descriptive of contents. Divide contents of binder into divisions listed below, separated by divider tabs:
 - a. General Information and Summary
 - b. Domestic hot Water Systems
 - c. Automatic Temperature Controls
 - d. Special Systems
 2. Report Contents: Provide following minimum information, forms and data:
 - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Include certification sheet containing seal and name address, telephone number, and signature of Certified Test and Balance Engineer. Include in this division listing of the instrumentations used for the procedures along with proof of calibration.
 - b. Remainder of the report shall contain appropriate forms containing as minimum, information indicated on standard report forms prepared by AABC and NEBB, for each respective item and system. Prepare schematic diagram for each item of equipment and system to accompany each respective report form.
 3. Reports shall be submitted no later than 30 days after substantial completion.
- H. Final submittal shall include but not be limited to following:
1. List of equipment used to perform test and procedures.
 2. Equipment performance data and equipment curves with actual points of performance indicated on curves as compiled during balancing.
 3. Domestic hot water system component flow rates, pressures and temperatures.
 4. On balance report documents record date and time of reading.

1.4 QUALITY ASSURANCE

- A. Agency Qualifications:
1. General Contractor shall employ the services of independent testing, adjusting,

and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance the building domestic hot water systems to produce design objectives. Services shall include checking installations for conformity to design, measurement and establishment of fluid quantities of plumbing systems as required to meet design specifications, and recording and reporting results.

2. Certified by National Environmental Balancing Bureau (NEBB) or by Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in State in which services are to be performed, certified by NEBB or AABC as Test and Balance Engineer.
- B. Work shall be accomplished in accordance with specifications. Procedures specified shall be followed and, if not specifically described herein, in general, shall be in accordance with Associated Air Balance Council's National Standards or National Environmental Balancing Bureau's Procedural Standards.
- C. Design Review:
1. Review all design drawings and specifications. Review shall include:
 - a. Control device location and balancing devices location in piping systems.
 - b. Indicate additional balancing devices required for proper balancing.
 - c. Specifications on all devices required for balancing.
 - d. Note any potential noise problems.
 2. Within 90 days of award of contract, meet with the Architect, Mechanical Contractor, and Building Automation System Contractor to review procedures and agenda and comments on design documents as to potential problem areas.
- D. Shop Drawing Review:
1. Review "Instrumentation and Control for HVAC" shop drawing submittals noting any potential balancing problems. Note comments on submittal, sign, stamp and return to General Contractor. All "Instrumentation and Control for HVAC" submittals must be reviewed by balancing agency prior to review by Architect.
- E. Pre-Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct conference with Architect and representatives of installers of mechanical systems. Objective of conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.
- F. During construction, balancing agency shall inspect the installation of pipe systems, temperature controls, and other component parts of plumbing system. Inspections shall be performed periodically as work progresses. Minimum of two inspections are required as follows: (1) when 60 percent of piping is installed; (2) when 90 percent of equipment is installed. Balancing agency shall submit brief written report of each inspection to Owner and Architect.
- G. Standards:
1. Associated Air Balance Council (AABC) Publication:
 - a. National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems, Latest Edition.
 2. American Society of Heating, Refrigeration and air Conditioning Engineers (ASHRAE) Publications:

- a. "ASHRAE Research Report No. 1162, "Air Flow Measurements at Intake and Discharge Openings and Grilles," ASHVE Transactions, Volume 46.
- b. ASHRAE Handbook of Fundamentals, Latest Edition.
- 3. American National Standards Institute (ANSI) Publications:
- 4. National Environmental Balancing Bureau (NEBB)
 - a. Procedural Standards for Testing-Balancing- Adjusting of Environmental Systems, Latest Edition.

1.5 OWNER'S INSTRUCTIONS

- A. Balancing contractor's technician along with his balancing engineer shall provide four (4) hours of instruction to Owner's engineers on balancing methods, procedures and equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SYSTEM BALANCE - GENERAL REQUIREMENTS

- A. Balance domestic hot water systems to obtain water quantities indicated and required for proper operation of system.
- B. Field work performed under this Section shall be provided under direct supervision of a Registered Professional Engineer.
- C. Furnish services for complete adjustment of water system distribution and controls.
- D. During all tests, it shall be demonstrated that systems shall be free from leaks and all parts of system will operate correctly. If not, report deficiencies to Contractor and Owner. Balancing Firm shall make final adjustments to system as may be required for proper operation, maintaining correct flow rates in all parts of the building.
- E. Preliminary Work:
 - 1. Inspect project site prior to starting adjustments to verify completion of trades, including general construction, piping system, building automation systems, and electrical systems, as they relate to balancing work. Verification shall include but not be limited to following:
 - a. Piping System (domestic hot water):
 - b. Already cleaned and flushed by mechanical contractor.
 - c. Chemical treatment operating, or applicable to system.
 - d. System filled and vented of air under Division 22.
 - e. Proper direction of rotation for motor-driven equipment and for proper speed on multi-speed motors.
 - f. Balancing devices are installed and accessible.
 - g. Control device connections.
 - h. Note problems in general construction of the building that might effect systems performance such as sealing of windows, building joints, exhaust shafts, etc.
 - i. Problems discovered during this inspection shall be reported to General Contractor and Owner.
 - 2. Contractor shall certify in writing that each piping system has been prepared as per this Section, indicating dates procedures were done and which contractor did work. Submit in writing to Architect before beginning balancing work.

- F. Balancing of domestic hot water circulation systems and parts installed under this Contract to obtain water quantities and temperature drops in all parts of system shown on plans, in specifications on approved shop drawings or as required by Architect.

3.2 DOMESTIC HOT WATER SYSTEM BALANCE

- A. In conjunction with Instrumentation and Controls System Technician, pumps shall be started per design sequence. With manual valves open, and control valves in normal position, adjust discharge balancing valve to obtain design flow. Compare data with pump submittal curve. If test point falls on curve, proceed with balancing. If recorded data does not fall on pump curve, plot new curve parallel with other curves on chart, from zero to maximum flow. Open discharge balancing valve to full and record discharge pressure, suction pressure and total head. Readjust balancing valve to obtain suction and discharge design flow and pressure, and record data. Check and record pump motor voltage and amperage. Pump motor shall not be overloaded.
- B. With pump system adjusted, perform following tests, compile data and submit report:
1. Pumps:
 - a. Design Data
 - 1) Flow and total dynamic head.
 - 2) pump speed, and motor output.
 - b. Installed equipment
 - 1) Manufacturer, size and model number.
 - 2) Type drive.
 - 3) Motor rating, voltage, and phase.
 - 4) Full-load amperes.
 - c. Field Test
 - 1) Discharge pressures: Full flow and zero flow.
 - 2) Suction pressures: Full flow and zero flow.
 - 3) Operating flow and total dynamic head
 - 4) No-load amperes (where possible.)
 - 5) Full-flow amperes, zero-flow amperes.
 - 6) Calculated motor output.
- C. With pump system properly adjusted, proceed with following tests adjustments and compilation of data:
1. Pipe Mains and Branches:
 - a. Adjust branch balancing valves to obtain pressure and flowrates required.
 - b. Provide the following:
 - 1) Manufacturer's model number, size of heat exchanger, number of passes.
 - 2) Design and actual flow rate and pressure drop.
 - c. Heat transfer equipment including domestic hot water.
 - 1) Measured Parameters
 - a) Flowrate.
 - b) Heat transfer through water heater.
 - c) Entering and leaving temperatures.
 - d) Pressure drops.
 - 2) Equipment data
 - a) Manufacturer and model number.
 - b) Motor output horsepower.
 - c) Serial numbers.

- 3) Design Data
 - a) Include design data in submittal for comparison.

3.3 CALIBRATION

- A. During testing and balancing, inspect temperature sensors, pressure sensors, digital indicators, and thermometers, etc. provided under Division 22. Report discrepancies to the Contractor for replacement or recalibration.

3.4 RE-BALANCE

- A. After Architect's review of test and balance report submittal, make adjustment in any balancing point as required by Architect, to correct discrepancies between balance report and design, at no additional cost.

3.5 FINAL BALANCE

- A. Visit site within one year after building occupancy if necessary to adjust and rebalance, any system required by Owner, to resolve any and all complaints. After final balance, revise previous submittal and resubmit to architect for record purpose. Rebalance and resubmittals shall be done at no additional cost to Owner.

END OF SECTION

SECTION 22 0700

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the contract, including General and Supplemental Conditions and Division 01 Specifications, apply to this section and all sections of Division 22.

1.2 SUMMARY

- A. This section Includes:
 - 1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - 2. Insulating cements.
 - 3. Adhesives.
 - 4. Mastics.
 - 5. Lagging adhesives.
 - 6. Sealants.
 - 7. Factory-applied jackets.
 - 8. Field-applied fabric-reinforcing mesh.
 - 9. Field-applied cloths.
 - 10. Field-applied jackets.
 - 11. Tapes.
 - 12. Securements.
 - 13. Corner angles.
 - 14. Insulation for handicapped fixtures.
- B. Related Sections: The following sections contain requirements that relate to this section.
 - 1. Section 22 05 03 – “Pipes and Tubes for Plumbing Piping and Equipment:” Product requirements for piping and valves.
 - 2. Section 22 05 16 – “Expansion Fittings and Loops for Plumbing Piping:” Product requirements for expansion loops.
 - 3. Section 22 05 32 – “General Duty Valves for Plumbing Piping:.” Product requirements for valves.
 - 4. Section 22 05 29 – “Hangers and Supports for Plumbing Piping and Equipment:” Product and Execution requirements for inserts at hanger locations.
 - 5. Section 22 05 48 – “Vibration and Seismic Controls for Plumbing and Piping Equipment:” Product requirements for vibration isolators.
 - 6. Section 22 05 53 – “Identification for Plumbing Piping and Equipment:” Product requirements for plumbing piping and equipment identification.

1.3 REFERENCES

(Unless otherwise noted, references apply to “latest editions.”)

- A. ASTM International:

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
4. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
5. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
6. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
7. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
8. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
9. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
10. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
11. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
12. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
13. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
14. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
15. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
16. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
17. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
18. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
19. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
20. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
21. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
22. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
23. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

1.4 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Samples: Submit two samples of representative size illustrating each insulation type.

- D. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
- B. Perform Work in accordance with all applicable codes, standards and local authorities having jurisdiction requirements.
- C. Maintain one copy of each document on site.
- D. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- E. Insulation materials shall be tested and rated according to ASTM Test Method C-177 to determine k-factors. ASTM C 335 is for pre-formed pipe insulation. Note: C177 is for flat slab materials such as board products, etc.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience, and service facilities within 50 miles of the project.
- B. Applicator: Company specializing in performing Work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping. Remove and replace any wet or damaged unsatisfactory insulation at the architect's direction.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Furnish five year manufacturer warranty for man made fiber.

1.11 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 – “Hangers and Supports for Plumbing Piping and Equipment.”
- B. Coordinate clearance requirements with piping Installer for piping insulation application, and equipment Installer for equipment 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.

1.12 DEFINITIONS

- A. ASJ: Al-service jacket.
- B. FSK: Foil, scrim, Kraft paper.
- C. FSP: Foil, Scrim, polyethylene.
- D. PVDC: Polyvinylidene chloride.
- E. SSL: Self-sealing lap.
- F. ASJ: All service jacket composed of aluminum foil reinforced with glass scrim bonded to a Kraft paper interweaving with an outer film layer leaving no paper exposed.
- G. PSK: Poly Scrim Kraft.

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. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

- A. Refer to Part 3 execution: schedule for requirements regarding where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, mercury compounds, or formaldehyde.

- C. Insulation products shall contain no formaldehyde-based binders.
- D. When product to be in contact with austenitic stainless steel is tested according to ASTM C795 (which includes ASTM C692 and ASTM C871), the PH of the leach water from the specific material supplied shall be greater than 7.0 but not greater than 11.7 at 77°F (25°C). An acceptable proportion of sodium plus silicate ions to the chloride ions as found by leaching from the insulation is shown in the "plot point" of figure 6 in ASTM C795.
- E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 - 1. Products:
 - a. Pittsburgh Corning; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas-Super K.
 - c. Specialty Products & Insulation Company (SPI), Lancaster, PA., Cellular, glass fabricator.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 - 6. Maximum K-Factor: 0.29 at 75 deg. F. mean temperature.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Closed-cell polyolefin/polyethylene insulation is not acceptable as a substitution for ASTM C534 closed-cell rubber materials.
 - 1. Products:
 - a. Aeroflex USA Inc.: Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. Nomaco; K-Flex Pipe
 - 2. Water Vapor Permeability: 0.02 perm-inch per ATM E96 Procedure A.
 - 3. Warranty: 25 year warranty against breakdown of the membrane due to ultraviolet radiation.
 - 4. Seal Tape: Thermoplastic rubber membrane backed with pressure sensitive adhesive.
- H. 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 III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 - 1. Products:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite, Duct Wrap.
 - c. Johns Manville; Microlite XG.
 - d. Knauf Insulation; Friendly Free Duct Wrap with Ecosse® Technology.
 - e. Owens Corning; All-Service Duct Wrap Type 100.
 - 2. Maximum K-Factor: 0.24 at 75 deg. F. and material thickness compressed 25%.

3. Minimum Density: 1.5 pounds per cubic foot.
- I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 1. Products:
 2. CertainTeed Corp.; Commercial Board.
 3. Johns Manville; 800 Series Spin-Glas, Type 814.
 4. Knauf Insulation; Insulation Board with Ecose® Technology.
 5. Owens Corning; Fiberglas 700 Series.
 - J. Mineral-Fiber, Preformed Pipe Insulation:
 1. Products:
 - a. Johns Manville; Micro-Lok, Micro-Lok HP Fiberglass pipe insulation.
 - b. Knauf Insulation; Earthwool 1000 Pipe insulation with Ecose® Technology.
 - c. Knauf Insulation; Earthwool Redi-Klad 1000 Pipe insulation with Ecose® Technology.
 - d. Owens Corning; Fiberglas Pipe Insulation, with factory applied all-service jacket (ASJ), Type: SSL II®
 - e. Owens Corning Vapor Wick® (For domestic cold water applications)
 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type *, Grade A, with factory-applied ASJ-SSL, or ASJ+SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 3. Type II, 1200 degree F Materials: Mineral or glass fibers bonded with thermosetting resin. Comply with ASTM C547, Type II, Grade A, with Factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 4. Maximum K-Factor: 0.23 at 75 deg. F mean temperature; 0.34 at 250 deg. F mean temperature.
 - K. 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. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 1. Products:
 - a. Certain Teed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation, with Ecose® Technology - 850°F.
 - d. Knauf Insulation; Kwik Flex Pipe & Tank Insulation with Ecose® Technology.
 - e. Owens Corning; Fiberglas® Pipe and Tank Insulation for systems operating at temperatures to 650°.
 2. Maximum K-Factor: 0.24 at 75 deg. F mean temperature; 0.39 at 300 deg. F mean temperature.
 3. Minimum Density: 2.5 pounds per cubic foot.

2.3 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.4 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. Cellular-Glass and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 81-84.
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products:
 - a. Armacell LCC; 520 BLV Adhesive.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-60.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 85-70.
 - b. Eagle Bridges - Marathon Industries, Inc.; 225.
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 85-70.
 - b. Eagle Bridges - Marathon Industries, Inc.; 225.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products:
 - a. Dow Chemical Company (The); 739, Dow Silicone.

2.5 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 30-90.

- b. Eagle Bridges - Marathon Industries, Inc.; 590.
 - c. Mon-Eco Industries, Inc.; 55-40.
 - d. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - b. Eagle Bridges - Marathon Industries, Inc.; 550.
 - c. Mon-Eco Industries, Inc.; 55-50.
 - d. Vimasco Corporation; WC-1/WC-5.
 - 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 200 deg F.
 - 4. Solids Content: 63 percent by volume and 73 percent by weight.
 - 5. Color: White.

2.6 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 81-42W.
 - b. Eagle Bridges - Marathon Industries, Inc.; 130.
 - c. Vimasco Corporation; 713/714.
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
 - 3. Service Temperature Range: Minus 50 to plus 180 deg F.
 - 4. Color: White.

2.7 SEALANTS

- A. Joint Sealants:
 - 1. Joint Sealants for Cellular-Glass and Polyisocyanurate Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - b. Eagle Bridges - Marathon Industries, Inc.; 405.
 - c. Mon-Eco Industries, Inc.; 44-05.
 - d. Pittsburgh Corning Corporation; Pittseal 444.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Permanently flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 5. Color: White or gray.
- B. FSK and Metal Jacket Flashing Sealants:
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 95-44.

- b. Eagle Bridges - Marathon Industries, Inc.; 405.
- c. 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.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. ASJ+ SSL: All service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interweaving with an outer film layer leaving no paper exposed.
4. Redi-Klad Jacket: Factory applied venture clad 5-ply weather and abuse resistant with self-sealing lap. Zero permeability per ASTM E 96-05; puncture resistance 35.4 kg (189.3_N) per ASTM D 1000; tear strength 4.3lb (19.4_N) per ASTM D 624, thickness 14.5 mils (0.0145"); tensile strength 68 lb/inch width [306 N (32K9)/25mm.]
5. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.
6. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
7. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
8. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Products:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
9. Vinyl Jacket: UL-rated white vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.
10. ASJ: Owens Corning Evolution™ paper-free ASJ pipe insulation.
11. PSK Jacket, Polypropylene scrim with Kraft.

2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Products:

- a. Vimasco Corporation; Elastafab 894.
- B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
- C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with Kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 20 mil thickness; roll stock Ready for shop or field cutting and forming.
 - 1. Products:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: white.
 - 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 and mechanical joints minimum 20 mil thickness.
 - 5. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
 - 1. Products:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - 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. Thickness:
 - 1) Up to 24 inch diameter, width, or height: 0.016 inch minimum.
 - 2) 25 inch to 59 inch diameter, width, or height: 0.024 inch minimum.
 - 3) 60 inch and larger diameter, width, or height: 0.032 inch minimum.
 - c. Finish: Smooth finish.
 - d. Color: White
 - e. Moisture Retarder: 3-mil- thick Polysurlyn (co-extrusion of polyethylene and Dupont Surlyn®, heat laminated to the metal jacketing).
 - f. Factory-Fabricated Fitting Covers:

- 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and longradius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
1. Products:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard; Insulrap No Torch 125.
- F. Pipe Sound Lagging: Loaded vinyl with fibrous glass scrim reinforced aluminum foil facing over 2-inch thick quilted fiberglass decoupler. Loaded vinyl shall be 2 psf minimum surface weight. Glass fiber pipe wrap shall be semi-rigid, preformed type, 2- inch minimum thickness, 1-1/2 pcf density.
1. Manufacturers:
 - a. Kinetics.
 - b. Sound Seal.
 2. Sound Transmission Class (STC) Rating: 26.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - 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 in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.

3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.
1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.

2.12 SECUREMENTS

- A. Bands:
1. Products:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.
 - a. Products:

- 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
- a. Products:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Products:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Products:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Products:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Manufacturers:

- 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
1. Manufacturers:
 - a. ACS Industries, Inc.
 - b. C & F Wire.
 - c. Childers Products.
 - d. PABCO Metals Corporation.
 - e. RPR Products, Inc.

2.13 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

2.14 HANDICAPPED WHEEL/CHAIR PLUMBING FIXTURE PIPING INSULATION

- A. Manufacturer:
1. TRUEBRO, INC.
- B. Product:
1. ADA-conforming, wheelchair accessible lavatory P-trap and angle valve assemblies shall be covered with white, molded, antimicrobial TRUEBRO, INC. Lav Guard 2 under sink pipe covers. Cover shall have internal, E-Z Tear-To-Fit trim feature for square, clean trimming-internal ribs-and built-in, concealed E-Z Grip fasteners (no cable-tie fasteners allowed.)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify piping and equipment to be insulated has been tested before applying insulation materials.
- B. Verify surfaces to be insulated are clean and dry, with foreign material removed.

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 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, and 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. Install insulation continuously through hangers and around anchor attachments.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at 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.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. 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 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer 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.
- N. Cut and install insulation in a manner to avoid compressing insulation more than 25 percent of its original nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. 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.
- Q. 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.
 8. Flanges.

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 Below-Grade 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.
- F. Insulation Installation at Floor Penetrations:
1. Install insulation continuously through floor penetrations.

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Secure insulation with anchor pins and speed washers. Insulation for tanks and vessels should only be applied using weld pins or self-adhesive pins (depending on the circumstances) and speed washers. Adhesive should not be used to secure insulation to the tanks or vessels except when utilizing flexible elastomeric insulation.
1. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 2. Protect exposed corners with secured corner angles.
 3. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 5. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

6. Stagger joints between insulation layers at least 3 inches.
 7. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 8. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 9. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate removable, re-useable metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Covers for split case pumps shall be constructed with insulated housing in two sections with upper section removable for access to casing. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 2. Fabricate boxes from aluminum or stainless steel, at least 0.050 inch thick.
 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 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. Fittings shall be insulated to same thickness as the adjoining insulation. Apply fittings per fitting manufacturer's instructions. When required by specification, a hard insert of sufficient length shall be utilized to avoid compression of the 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 wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe

insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric 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.
 9. 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, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation 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. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but 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 cut sections of cellular glass block insulation of same thickness as pipe 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. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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.

3.9 MINERAL-FIBER INSULATION INSTALLATION

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, unless jacketing with self-sealing laps are used.
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 but 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.

3.10 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
1. Where rubber membrane jackets are indicated, install the membrane using the manufacturer's recommended adhesive. Before use thoroughly stir the adhesive. Replace the container lid when work is interrupted. If required thin the adhesive as recommended by the manufacturer.
 2. Using a sheepskin or similar roller apply a primer coat of adhesive to the roof surface, priming only the area of roof where the membrane will be laid the same day. Allow adhesive to dry.
 3. Unroll the membrane and fold back approximately half its length.
 4. Apply adhesive with a sheepskin or similar roller to the underside of the membrane ensuring the weld area is kept free of adhesive and allow to touch dry.
 5. Carefully roll out the membrane over the previously primed surface and roll with water filled roller.
 6. Fold back other half of the roll of membrane and repeat the procedure.
 7. Unroll the next roll of membrane, ensuring the end laps are staggered and the side overlaps the previously installed sheet by 2 inches.
 8. Repeat the adhering process.
 9. Fully hot air weld the 2-inch side lap, allow to cool completely.

10. Mechanically check the integrity of the cooled weld by running a 3/16-inch wide screwdriver (with rounded edges) along the seam applying pressure into the seam.
11. Install Peel Stop and PVC Welding Cord at all perimeters, penetrations and changes of roof direction.

E. Pipe Sound Lagging:

1. Seal and fasten in accordance with manufacturer's written instructions to maintain specified STC rating.
2. Cover entire pipe with glass fiber wrap. Fill all voids with clean glass fiber scrap. Apply over this wrap an airtight cover of loaded vinyl. Do not connect the cover rigidly to pipe or hangers. Overlap longitudinal seams in loaded vinyl 2-inch minimum and tape with cloth-backed tape. Overlap edge seams 1-inch minimum and tape with cloth-backed tape or with acoustical sealant. Extend ends of cover within 1/2-inch of penetration through wall, ceiling, and/or floor. Seal annular gap between pipe lagging and penetration airtight with acoustic sealant.

3.11 FINISHES

- A. Finish Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Refer to 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.
- E. Clad-type weather-resistant jacket such as Venture clad may be used to finish plumbing equipment exposed to weather.
- F. Piping exposed to weather Knauf Earthwool Redi-Klad 1000 Pipe Insulation with Ecose® Technology may be utilized as long as it is installed per the manufacturer's installation procedures.

3.12 INSULATION APPLICATION SCHEDULE

- A. Acceptable insulation materials, thickness and vapor retarder requirements are identified for each application and size range. If more than one material is listed for an application and size range, selection from the materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Fire-suppression piping.
 2. Drainage piping located in crawl spaces.
 3. Below-grade piping.
 4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
 5. Vibration-control devices.
 6. Factory-insulated access panels and doors.

3.13 PLUMBING PIPING INSULATION APPLICATION SCHEDULE:

| SERVICE | INSULATION MATERIAL | INSULATION THICKNESS | VAPOR RETARDER REQUIRED |
|---|--------------------------|----------------------|-------------------------|
| DOMESTIC HOT AND RECIRCULATED HOT WATER PIPING | | | |
| Indoor Service: | | | |
| 1 ¼" diameter and smaller | Mineral Fiber | 1" | No |
| 1 ½" diameter and larger | Mineral Fiber | 1 1/2" | No |
| DOMESTIC COLD WATER PIPING (Except on piping inside apartment units) | | | |
| Indoor Service: | | | |
| 1 ¼" diameter and smaller | Mineral Fiber | ½" | Yes |
| 1 ½" diameter and larger | Mineral Fiber | 1" | Yes |
| Unconditioned Indoor Space (Refer to Note 1): | | | |
| All sizes | Mineral Fiber | 1-1/2" | Yes |
| AIR CONDITIONING CONDENSATE DRAIN, EQUIPMENT DRAIN, & HUMIDIFIER DRAIN PIPING | | | |
| All sizes | Flexible Elastomeric | ½" | Yes |
| ABOVE FLOOR DRAINS, TRAPS AND DRAIN PIPING WITHIN 10 FEET OF DRAIN RECEIVING CONDENSATE AND EQUIPMENT DRAIN WATER BELOW 60 DEGREES F | | | |
| All Sizes | Mineral Fiber | 1" | Yes |
| All sizes, Alternative Insulation Material | Flexible Elastomeric | 1" | Yes |
| EXPOSED SANITARY DRAINS AND DOMESTIC WATER SUPPLIES AND STOPS FOR FIXTURES FOR THE DISABLED | | | |
| Supply pipes and drain pipes – all sizes | TrueBro® LAV-Guard®-2 | - | Yes |
| INDOOR ABOVEGROUND HOT SERVICE DRAINS AND VENTS (Insulation for Personnel Protection) | | | |
| All sizes | Mineral Fiber | 1-1/2" | No |

3.14 PLUMBING EQUIPMENT INSULATION APPLICATION SCHEDULE

| SERVICE | INSULATION | INSULATION | VAPOR |
|---------|------------|------------|-------|
|---------|------------|------------|-------|

| | MATERIAL | THICKNESS | RETARDER REQUIRED |
|--|--|-----------|----------------------|
| PLUMBING EQUIPMENT INSULATION APPLICATION SCHEDULE | | | |
| DOMESTIC HOT WATER RE- CIRCULATION PUMP | Mineral Fiber Board | 1" | No |
| EXPANSION TANKS (FOR DOMESTIC HOT WATER DUTY) | Mineral Fiber Board; or Mineral Fiber Pipe and Tank | 1" | No |
| DOMESTIC HOT WATER HEATER TANKS | Mineral Fiber Board; or Mineral Fiber Pipe and Tank | 4" | No |

Notes:

1. Unconditioned spaces include locations where summer temperature and humidity conditions are similar to outdoor conditions (such as mechanical rooms ventilated with unconditioned outdoor air, parking garages, pedestrian tunnels, etc.)
2. Where rigid pipe insulation (cellular glass, etc.) is scheduled, provide mineral fiber through and 6 inches beyond pipe sleeves, to allow for pipe expansion.

3.15 FIELD APPLIED JACKET APPLICATION SCHEDULE

| SERVICE | FIELD APPLIED JACKET TYPE |
|--|-------------------------------|
| Indoor, exposed insulated piping within 12 feet of floor, for service temperatures 200 degrees F and below. | PVC |
| Indoor, exposed insulated piping greater than 12 feet above floor, generally. | None |
| Indoor, cold service piping (domestic cold water) greater than 12 feet above the floor, within spaces subject to outdoor temperature and humidity conditions (such as mechanical rooms, rooms ventilated with unconditioned outdoor air, etc.) | PVC |
| Indoor concealed piping | None |
| Garage exposed piping | Aluminum |
| Indoor, All Locations, Fittings and valves in piping systems at service temperatures 200 degrees F and below. | Factory Fabricated PVC covers |
| Piping in sound sensitive areas (as indicted on the drawings) | Pipe Sound Lagging (Note 3) |
| Equipment, generally (Refer to Notes 1 & 2) | Woven Glass Fiber Fabric |
| Equipment, cold surface (Refer to Notes 1 & 2) | PVC |

Jacket Application Schedule Notes:

1. Refer to Part 3 specification section titled "Equipment, Tank, and Vessel Insulation Installation" for requirements for removable, re-usable metal boxes lined with insulation at pumps.
2. Including factory insulated equipment without factory applied jacket.
3. If ductwork or piping indicated to have sound lagging also requires an additional field jacket, install sound lagging between insulation and additional field jacket.

END OF SECTION

SECTION 22 1000

PLUMBING PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to this section, and all sections of Division 22.

1.2 SUMMARY

- A. Section includes:
 - 1. Domestic water circulator pumps.
 - 2. Condensate removal pump.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Section 23 05 14 – “Common Motor Requirements”: Product requirements for motors for placement by this section.
 - 2. Section 22 05 48 – “Vibration and Seismic Controls for Plumbing Piping and Equipment”: Product requirements for vibrations isolators installed with pumps.
 - 3. Section 22 05 03 – “Pipes and Tubes for Plumbing Piping and Equipment”: Execution requirements for connection to pumps specified by this section.
 - 4. Section 22 05 23 – “General-Duty Valves for Plumbing Piping”: Product requirements for valves used in hydronic piping systems.
 - 5. Section 22 05 93 – “Testing, Adjusting and Balancing for Plumbing:” Requirements for balancing pumps.
 - 6. Section 26 05 19 – “Low Voltage Electrical Power Conductors & Cables”: Requirements for electrical wiring and cable connections to pumps specified by this section.
 - 7. Section 26 05 33 – “Raceways and Boxes for Electrical Systems:” Requirements of conduits and boxes housing electrical wiring and electric connections for pumps specified in this section.”

1.3 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the contract and Division 01 specification sections.
- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.
- C. Plumbing drainage specialties: Submit manufacturers catalog information with sizes, capacities, rough-in requirements, service sizes, and finishes.
- D. Plumbing supply specialties: Submit manufacturers catalog information with sizes, capacities, rough-in requirements, service sizes, and finishes.

- E. Pumps: Include capacities, pump curves, equipment performance, and electrical characteristics.
- F. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 REFERENCES

("Unless otherwise noted, references apply to "latest" "editions")

A. National Electrical Manufacturers Association:

- 1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Underwriters Laboratories, Inc.:

- 1. UL 778 – Motor Operated Water Pumps.

1.5 CLOSEOUT SUBMITTALS

- A. Provide closeout documentation in accordance with the Division 01 specification sections.
- B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.
- C. Maintain one copy of each document on site.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with all applicable codes, standards, and local authorities having jurisdiction requirements.
- B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products in this section with minimum three years experience and with service facilities within 50 miles of project.
- B. Installer: Company specializing in performing work of this section with minimum three years experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect pumps, panels and components by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Furnish five year manufacturer's warranty for pumps.

1.11 DEFINITIONS

- A. Lead Free:
 - 1. The pipes, pipe fittings, plumbing fittings or fixtures in plumbing systems that are intended to dispense potable water for human consumption, including drinking and cooking, shall be "lead free", containing not more than a weighted average of 0.25% lead with respect to the wetted surfaces.
 - 2. Solder and flux for soldered joints in potable water piping shall be "lead free", containing not more than 0.2% lead free.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER CIRCULATING, IN-LINE

- A. Basis of Design:
 - 1. Basis of design shall be the "90 Series" as manufactured by Bell and Gossett, a comparable product as manufacture by Armstrong, Grundfos and Taco shall be submitted for review as a comparable products.
 - 2. Pumps shall be lead free and shall meet model numbers, types, sizes, capacities, and electrical characteristics as indicated on the Contract Drawings. Acceptable manufacturers: Bell & Gossett, Taco, Armstrong, Grundfos.
- B. The pumps shall be of the horizontal, permanently lubricated type, specifically designed and guaranteed for quiet operation.
- C. The pumps shall have a steel shaft supported by permanently lubricated, sealed precision ball bearings. The pumps shall be equipped with a water-tight seal to prevent leakage. Mechanical seal faces to be carbon on silicon carbide. The motor shall be non-overloading at any point on the pump performance curve.
- D. The motor shall be of the drip-proof, sealed precision ball-bearing, quiet-operating construction. The permanent split-capacitor motor shall be equipped with thermal overload protection.
- E. Pumps shall be suitable for 225°F (107°C) operating temperature at 150 psig (10 bar) working pressure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.

3.2 INSTALLATION - PUMPS

- A. Install line size valving as indicated on the contract drawings on pump suction and discharges.

- B. Install elevator pump with shaft length allowing pump to be located minimum 24 inches (600 mm) below lowest invert into sump pit and minimum 6 inches (150) clearance from bottom of sump pit.
- C. Lubricate pumps before start-up.
- D. All power and control wiring shall be performed per manufacturer's instructions and applicable codes, standards and the authority having jurisdiction.
- E. Install flexible connectors at or near pumps where piping configuration does not absorb vibration. Refer to Section 22 05 48 - "Vibration and Seismic Controls for Plumbing Piping and Equipment".
- F. Third Party Testing, NSF, and OSHA Requirement:
 - 1. The package shall be UL Listed as a system for its intended use, a NSF 61 approved system per NSF 61 guidelines so meeting OSHA Federal Regulations 29 CFR 1910.303 and 399 as well as NFPA Pamphlet #70 (National Electric Code) Article 90-7, City of Los Angeles Approval Code, CMR248 Massachusetts State Plumbing Code Approval.
- G. Factory Test:
 - 1. The package shall be electrically and hydrostatically tested before shipment, in addition, each system shall be factory tested from 0-100% of flow and pressure. Provide certified x-y test report.
- H. Startup:
 - 1. The factory authorized local representative shall provide (2) hours of startup and field training. Record all start-up and training sessions. Provide the owner with three (3) copies of the recordings in digital versatile disk (DVD) format.

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, fittings, and specialties inside the building.
 - 2. Encasement for piping.
 - 3. Specialty valves.
 - 4. Flexible connectors.
 - 5. Water meters.
 - 6. Escutcheons.
 - 7. Sleeves and sleeve seals.
 - 8. Wall penetration systems.

1.3 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Water meters.
 - 6. Backflow preventers and vacuum breakers.
 - 7. Escutcheons.
 - 8. Sleeves and sleeve seals.
 - 9. Water penetration systems.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.
- C. Comply with NSF 61 for potable domestic water piping and components.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 OPERATION AND MAINTENANCE DATA

- A. Prepare operation and maintenance data in accordance with Division 01 specifications

1.7 WARRANTY

- A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
- B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.
 - 1. Warranty may transfer to subsequent owners.
 - 2. Warranty Period for PEX Tubing: 30-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of installation.
 - 3. Warranty Period for Manifolds and Fittings: 5-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of installation.
 - 4. Warranty Period for Radiant Rollout Mat: 25-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of installation for tubing. 10-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of installation for in-slab engineered polymer fittings.

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 CROSSLINKED POLYETHYLENE (PEX) PIPE AND FITTINGS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following
 - 1. Basis of Design Manufacturer: Uponor.
Contact: 5925 148th Street West, Apple Valley, MN 55124; Telephone: 800.321.4739, 952.891.2000; Fax: 952.891.2008; Website: www.uponorpro.com
 - 2. Tubing
 - a. Material: Engel-method crosslinked polyethylene (PEX-a)
 - b. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third-party agency.
 - c. Pressure Ratings: Standard Grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), a division of the Society of the Plastics Industry (SPI).
 - d. 200 degrees F (93 degrees C) at 80 psi (551 kPa)
 - e. 180 degrees F (82 degrees C) at 100 psi (689 kPa)
 - f. 73.4 degrees F (23 degrees C) at 160 psi (1102 kPa)
 - g. Show compliance with ASTM E119 and ANSI/UL 263 through certification listings through UL.
 - h. UL Design No. L557 — 1 hour wood frame floor/ceiling assemblies
 - i. UL Design No. K913 — 2 hour concrete floor/ceiling assemblies

- j. UL Design No. U372 — 1 hour wood stud/gypsum wallboard wall assemblies
 - k. UL Design No. V444 — 1 hour steel stud/gypsum wallboard wall assemblies
 - l. Minimum Bend Radius (Cold Bending): Six times the outside diameter.
 - m. Barrier Tubing Type: Wirsbo hePEX or equal
 - n. Tubing shall have an oxygen-diffusion barrier that does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 104 degrees F (40 degrees C) water temperature in accordance with German DIN 4726.
 - o. Nominal Inside Diameter: Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated in the system design.
3. Fittings
ASTM F1960 cold-expansion fitting manufactured from the following material types:
- a. UNS No. C69300 Lead-free (LF) Brass
 - b. 20% glass-filled polysulfone as specified in ASTM D6394
 - c. Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D6394
 - d. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D6394
 - e. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D6394
 - f. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".

2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 - 5. Copper Pressure-Seal-Joint 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) Elkhart Products Corporation; Industrial Division.
 - 2) NIBCO INC.
 - 3) Viega; Plumbing and Heating Systems.
 - b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - 6. Copper-Tube Extruded-Tee Connections:
 - 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) T-DRILL Industries Inc.
 - b. Description: Tee formed in copper tube according to ASTM F 2014.

- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
 - 1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 2. Copper Pressure-Seal-Joint 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) Elkhart Products Corporation; Industrial Division.
 - 2) NIBCO INC.
 - 3) Viega; Plumbing and Heating Systems.
 - b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - c. NPS 3 and NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.4 CPVC PIPING

- A. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
- B. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

2.5 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, 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.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- E. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
- F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.6 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Form: Tube.
- C. Material: LLDPE film of 0.008-inch minimum thickness.
- D. Color: Natural.

2.7 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.
- C. CPVC Union Ball 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. American Valve, Inc.
 - b. Asahi/America, Inc.
 - c. Colonial Engineering, Inc.
 - d. Fischer, George Inc.
 - e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
 - f. IPEX Inc.
 - g. NIBCO INC.
 - h. Sloane, George Fischer, Inc.
 - i. Spears Manufacturing Company.
 - j. Thermoplastic Valves Inc.
- 2. Description:
 - a. Standard: MSS SP-122.
 - b. Pressure Rating: 125 psig at 73 deg F.
 - c. Body Material: CPVC.
 - d. Body Design: Union type.
 - e. End Connections for Valves NPS 2 and Smaller: Detachable, threaded.
 - f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket.
 - g. Ball: CPVC; full port.
 - h. Seals: PTFE or EPDM-rubber O-rings.
 - i. Handle: Tee shaped.

- D. CPVC Ball Check 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. American Valve, Inc.
 - b. Asahi/America, Inc.
 - c. Colonial Engineering, Inc.
 - d. Fischer, George Inc.
 - e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
 - f. IPEX Inc.
 - g. NIBCO INC.
 - h. Sloane, George Fischer, Inc.
 - i. Spears Manufacturing Company.
 - j. Thermoplastic Valves Inc.
- 2. Description:
 - a. Pressure Rating: 125 psig at 73 deg F.
 - b. Body Material: CPVC.
 - c. Body Design: Union-type ball check.
 - d. End Connections for Valves NPS 2 and Smaller: Detachable, socket.
 - e. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket.
 - f. Ball: CPVC.
 - g. Seals: EPDM- or FKM-rubber O-rings.

2.8 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.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Dresser Piping Specialties.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc; a Sensus company.
 - g. Viking Johnson; c/o Mueller Co.
- D. Plastic-to-Metal Transition Fittings:
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. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
 2. Description: CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket end.
- E. Plastic-to-Metal Transition 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. Colonial Engineering, Inc.
 - b. NIBCO INC.
 - c. Spears Manufacturing Company.
 2. Description: CPVC or PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.

2.9 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. Central Plastics Company.

- c. EPCO Sales, Inc.
 - d. Hart Industries International, Inc.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - f. Zurn Plumbing Products Group; Wilkins Water Control Products.
2. Description:
- a. Pressure Rating: 150 psig at 180 deg F.
 - b. 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. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric Couplings:
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. Calpico, Inc.
 - b. Lochinvar Corporation.
2. Description:
- a. Galvanized-steel coupling.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Female threaded.
 - d. Lining: Inert and noncorrosive, thermoplastic.
- E. Dielectric Nipples:
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. Perfection Corporation; a subsidiary of American Meter Company.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Company.
2. Description:
- a. Electroplated steel nipple complying with ASTM F 1545.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Male threaded or grooved.
 - d. Lining: Inert and noncorrosive, propylene.

2.10 FLEXIBLE CONNECTORS

- 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. Flex-Hose Co., Inc.

2. Flexicraft Industries.
 3. Flex Pression, Ltd.
 4. Flex-Weld, Inc.
 5. Hyspan Precision Products, Inc.
 6. Mercer Rubber Co.
 7. Metraflex, Inc.
 8. Proco Products, Inc.
 9. Tozen Corporation.
 10. Unaflex, Inc.
 11. Universal Metal Hose; a Hyspan company
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.11 WATER METERS

- A. Displacement-Type Water Meters:
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. AALIANT; a Venture Measurement Product Line.
 - b. ABB.
 - c. Badger Meter, Inc.
 - d. Carlon Meter.
 - e. Mueller Company; Water Products Division.
 - f. Schlumberger Limited; Water Division.
 - g. Sensus Metering Systems.
 2. Description:
 - a. Standard: AWWA C700.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: Nutating disc; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility.
 - e. Case: Bronze.
 - f. End Connections: Threaded.
- B. Turbine-Type Water Meters:
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. AALIANT; a Venture Measurement Product Line.
 - b. ABB.
 - c. Badger Meter, Inc.

- d. Hays Fluid Controls.
- e. Master Meter, Inc.
- f. McCrometer.
- g. Mueller Company; Water Products Division.
- h. Schlumberger Limited; Water Division.
- i. SeaMetrics Inc.
- j. Sensus Metering Systems.

2. Description:

- a. Standard: AWWA C701.
- b. Pressure Rating: 150-psig working pressure.
- c. Body Design: Turbine; totalization meter.
- d. Registration: In gallons or cubic feet as required by utility company .
- e. Case: Bronze.
- f. End Connections for Meters NPS 2 and Smaller: Threaded.
- g. End Connections for Meters NPS 2-1/2 and Larger: Flanged.

C. Compound-Type Water Meters:

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. ABB.
- b. Badger Meter, Inc.
- c. Master Meter, Inc.
- d. Mueller Company; Water Products Division.
- e. Schlumberger Limited; Water Division.
- f. Sensus Metering Systems.

2. Description:

- a. Standard: AWWA C702.
- b. Pressure Rating: 150-psig working pressure.
- c. Body Design: With integral mainline and bypass meters; totalization meter.
- d. Registration: In gallons or cubic feet as required by utility company.
- e. Case: Bronze.
- f. Pipe Connections: Flanged.

D. Remote Registration System: Encoder type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

2.12 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.
- E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.
- F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew or spring clips.

- G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.13 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- D. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
- E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.14 SLEEVE SEALS

- 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. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex, Inc.
 - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe 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: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.15 GROUT

- A. Standard: ASTM C 1107, 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 EARTHWORK

- A. Comply with requirements in Division 31 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 copper tubing under building slab according to CDA's "Copper Tube Handbook."
- 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 water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- F. Install domestic water piping level without pitch and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. 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.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.
- M. 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.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install PEX piping with loop at each change of direction of more than 90 degrees.

- Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- R. 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.
- S. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

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. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- E. Soldered Joints: 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."
- F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
- J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Label ceiling grid to identify all shut offs within corridors.
- C. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- D. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- E. Install ball valves in each hot-water circulation return branch.

3.5 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.

3.6 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 couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.7 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump.
- B. Install bronze-hose flexible connectors in copper domestic water tubing.
- C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.8 WATER METER INSTALLATION

- A. Rough-in domestic water piping for water meter installation, and install water meters according to utility company's requirements.

- B. Install water meters according to AWWA M6, utility company's requirements, and the following:
- C. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
- D. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

3.9 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 tubing 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 copper tubing every 10 feet.
- F. Install supports for vertical steel piping every 15 feet.
- G. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
 - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
 - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
 - 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 - 5. NPS 6: 48 inches with 3/4-inch rod.
 - 6. NPS 8: 48 inches with 7/8-inch rod.
- H. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

- I. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.10 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. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. 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.
 - 3. 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.

3.11 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 4. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw or spring clips.
 - 5. Bare Piping in Equipment Rooms: One piece, cast brass stamped steel with set screw or spring clips.
 - 6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.12 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.

- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
 - 1. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE.
 - 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Stack sleeve fittings].
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
 - c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 - 4. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE.
 - 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - c. Do not use sleeves when wall penetration systems are used.
 - 6. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. PVC pipe sleeves for pipes smaller than NPS 6.
- L. 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 in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.13 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space

between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.14 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.15 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. 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.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.16 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.17 CLEANING

- A. Clean and disinfect 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.

3.18 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. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
- E. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; copper solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 3. CPVC, Schedule 80 pipe; CPVC, Schedule 80 socket fittings; and solvent-cemented joints.
 - 4. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints.

3.19 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 butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe 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.
- C. Iron grooved-end valves may be used with grooved-end piping.
- D. CPVC valves matching piping materials may be used.

3.20 AS-BUILT DRAWINGS

Provide separate as-built drawings and record documents of all fire protection systems as required hereinbefore in this section.

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 piping specialties:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Balancing valves.
 - 5. Strainers.
 - 6. Hose bibbs.
 - 7. Wall hydrants.
 - 8. Drain valves.
 - 9. Air vents.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
 - 2. Division 22 Section "Domestic Water Piping" for water meters.
 - 3. Division 22 Section "Domestic Water Filtration Equipment" for water filters in domestic water piping.
 - 4. Division 22 Section "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
 - 5. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
 - 6. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Rough bronze.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
4. Configuration: Designed for horizontal, straight through flow.
5. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Standard: ASSE 1003.
2. Pressure Rating: Initial working pressure of 150 psig.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
2. Body: Brass or bronze,
3. Size: Same as connected piping, but not larger than NPS 2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

C. Memory-Stop Balancing Valves:

1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.

3. Size: NPS 2 (DN 50) or smaller.
4. Body: Copper alloy.
5. Port: Standard or full port.
6. Ball: Chrome-plated brass.
7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel with memory-setting device.

2.5 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.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.033 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
6. Drain: [Factory-installed, hose-end drain valve].

2.6 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 or field-installation, 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: Operating key.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS

A. Non freeze Wall Hydrants:

1. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

7. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Nozzle and Wall-Plate Finish: Polished nickel bronze or Rough bronze.
9. Operating Keys(s): Two with each wall hydrant.

B. Vacuum Breaker Wall Hydrants:

1. Standard: ASSE 1019, Type A or Type B.
2. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
3. Classification: Type A, for automatic draining with hose removed
4. Pressure Rating: 125 psig .
5. Operation: Loose key.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: NPS ½ or NPS ¾.
8. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 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 ½ minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
 - D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
 - E. Install balancing valves in locations where they can easily be adjusted.
 - F. Install Y-pattern strainers for water on supply side of each control valve and pump.
 - G. Install air vents at high points of water piping.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

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. Reduced-pressure-principle backflow preventers.
 2. Water pressure-reducing valves.
 3. Calibrated balancing valves.
- 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 according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing 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. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
- B. Related Sections include the following:
 - 1. Division 22 Section "Chemical Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.4 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.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
- C. Comply with HUD UM 77a Cast Iron Hubless Pipe and Fittings for Sanitary Drainage
 - 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - 2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Comply with HUD UM 79a ABS & PVC Plastic Pipe & Fittings for Drain Waste and Vent piping.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be:
 - 1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
- C. Aboveground, vent piping NPS 4 and smaller shall be:
 - 1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
- D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be:

1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- E. Underground, soil and waste piping NPS 5 and larger shall be:
1. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.

3.3 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- F. 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."
- G. 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 $\frac{1}{4}$ 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 $\frac{1}{8}$ -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.
- H. 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.
- I. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- J. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 2. Solvent Drainage System: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- L. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- M. Install underground [PVC] soil and waste drainage piping according to ASTM D 2321.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- 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. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. 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 (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. 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.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 - 2. NPS 3 (DN 80): 48 inches with 1/2-inch rod.
 - 3. NPS 4 and 5: 48 inches with 5/8-inch rod.
 - 4. NPS 6: 48 inches with 3/4-inch (19-mm) rod.
 - 5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.
- I. Install supports for vertical PVC piping every 48 inches.
- J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 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 (DN 65) and larger.

3.8 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 (30 kPa). 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 (250 Pa). 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.

3.9 PROTECTION

- A. Exposed [PVC] Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

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. This Section includes the following sanitary drainage piping specialties:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Floor drains.
 - 4. Roof flashing assemblies.
 - 5. Through-penetration firestop assemblies.
 - 6. Miscellaneous sanitary drainage piping specialties.
 - 7. Flashing materials.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

- 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 NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 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:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Josam Company; Blucher-Josam Div.
 - 4. Standard: ASME A112.3.1 for stainless steel for cleanout test tee.
 - 5. Size: Same as connected drainage piping

| NOMINAL PIPE SIZE (IN) | NOMINAL SIZE CLEANOUT |
|------------------------|-----------------------|
| 4" AND BELOW | SAME SIZE AS PIPE |
| 6 | 4" OR 6" |
| 8 | 6" OR 8" |
| 10" AND ABOVE | 8" |

- 6. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 7. Closure: Countersunk, cast-iron plug.
 - 8. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 9. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Oatey.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Light Commercial Operation.
 - h. Zurn Plumbing Products Group; Specification Drainage Operation.
 - i. Josam Company; Josam Div.
 - j. Kusel Equipment Co.
 - k. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - l. Josam Company; Blucher-Josam Div.
4. Standard: ASME A112.36.2M for adjustable housing cleanout.
5. Size:

| NOMINAL PIPE SIZE (IN) | NOMINAL SIZE CLEANOUT |
|------------------------|-----------------------|
| 4" AND BELOW | SAME SIZE AS PIPE |
| 6 | 4" OR 6" |
| 8 | 6" OR 8" |
| 10" AND ABOVE | 8" |

6. Type: Adjustable housing.
7. Body or Ferrule: Cast iron.
8. Clamping Device: Not required.
9. Outlet Connection: Spigot.
10. Closure: Brass plug with straight threads and gasket.
11. Adjustable Housing Material: Cast iron with threads.
12. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
13. Frame and Cover Shape: Round.
14. Top Loading Classification: Light Duty.
15. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
16. Standard: ASME A112.3.1.
17. Size: Same as connected branch.
18. Housing: Stainless steel.
19. Closure: Stainless steel with seal.
20. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

- a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
4. Standard: ASME A112.36.2M. Include wall access.
5. Size:

| NOMINAL PIPE SIZE (IN) | NOMINAL SIZE CLEANOUT |
|------------------------|-----------------------|
| 4" AND BELOW | SAME SIZE AS PIPE |
| 6 | 4" OR 6" |
| 8 | 6" OR 8" |
| 10" AND ABOVE | 8" |

- 6. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 7. Closure: Countersunk, drilled-and-threaded brass plug.
- 8. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 9. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
- 10. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

D. Plastic Floor Cleanouts:

- 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:
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Plastic Oddities; a division of Diverse Corporate Technologies.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
- 3. Size:

| NOMINAL PIPE SIZE (IN) | NOMINAL SIZE CLEANOUT |
|------------------------|-----------------------|
| 4" AND BELOW | SAME SIZE AS PIPE |
| 6 | 4" OR 6" |
| 8 | 6" OR 8" |
| 10" AND ABOVE | 8" |

- 4. Body: PVC.
- 5. Closure Plug: PVC.
- 6. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide Insert manufacturer's name; product name or designation or a comparable product by one of the following:
 - a. Commercial Enameling Co.
 - b. Josam Company; Josam Div.
 - c. MIFAB, Inc.
 - d. Prier Products, 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; Light Commercial Operation.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
4. Pattern: Area or Floor drain.
5. Body Material: Gray iron.
6. Seepage Flange: Required.
7. Clamping Device: Required.
8. Coating on Interior and Exposed Exterior Surfaces: Not required.
9. Sediment Bucket: Not required.
10. Top or Strainer Material: Nickel bronze.
11. Top of Body and Strainer Finish: Nickel bronze.
12. Top Shape: Round.
13. Top Loading Classification: Light Duty.
14. Trap Material: Cast iron.
15. Trap Pattern: Deep-seal P-trap.
16. Trap Features: Trap Gard flapper.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
3. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
4. Size: Same as connected soil, waste, or vent stack.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. 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.

B. 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.

C. 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.

D. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Frost-Resistant Vent Terminals

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

F. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..
2. Vent Pipe Flashing: 8 oz./sq. ft..

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.7 MOTORS

A. General requirements for motors are specified in Division 22 Section "Common Motor Requirements for Plumbing 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: Electrical devices and connections are specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to 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.
- 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 floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- I. Install through-penetration firestop assemblies in plastic conductors at floor penetrations.
- J. Assemble open drain fittings and install with top of hub 1 inch above floor.
- K. Install deep-seal traps on floor drains and other waste outlets, if indicated.

- L. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- M. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- N. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- O. Install vent caps on each vent pipe passing through roof.
- P. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- Q. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- R. Install wood-blocking reinforcement for wall-mounting-type specialties.
- S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- T. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. 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 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 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 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.
- 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. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
 - F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
 - G. Fabricate and install flashing and pans, sumps, and other drainage shapes.
- 3.4 LABELING AND IDENTIFYING
- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."
- 3.5 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 field-assembled specialties and their installation, including piping and electrical connections, and to assist in testing.
 - B. Tests and Inspections:
 1. Leak Test: After installation, charge system 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.
- 3.6 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

COMMERCIAL 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 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."
- C. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For commercial domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of commercial, electric, domestic-water heater, from manufacturer.

- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters 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.
- 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 Annex G, "Drinking Water System Components - Health Effects."

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 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, Domestic-Water Booster Heaters:
 - 1) Controls and Other Components: **[Three] [Five] <Insert number>** years.
 - b. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: **[Three] [Five] <Insert number>** years.
 - 2) Controls and Other Components: **[Three] [Five] <Insert number>** years.
 - c. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) and Other Components: **[Two] [Three] <Insert number>** years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Standard: UL 1453.
3. Storage-Tank Construction: **[Non-]**ASME-code, steel **[horizontal]** **[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 Annex G 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.

B. Capacity and Characteristics:

1. Capacity: **<Insert gal. (L)**
2. Recovery: **<Insert gph (L/s)>** at **[40 deg F (22 deg C)] [50 deg F (28 deg C)] [100 deg F (56 deg C)]** **<Insert temperature>** temperature rise.
3. Temperature Setting: **[125 deg F (52 deg C)] [140 deg F (60 deg C)] [180 deg F (82 deg C)]** **<Insert temperature>**.
4. Power Demand: **<Insert kilowatts>**.
5. Heating Elements:
 - a. Number of Elements: **[Two] [Three] [Six] [Nine]** **<Insert number>**.
 - b. Kilowatts Each Element: **<Insert kilowatts>**.
 - c. Number of Stages: **[One] [Two] [Three] [Four]** **<Insert number>**.
6. Electrical Characteristics:
 - a. Volts: **[120] [240] [277] [480]** **<Insert value>**.
 - b. Phases: **[Single] [Three]**.
 - c. Hertz: 60.
 - d. Full-Load Amperes: **<Insert value>**.
 - e. Minimum Circuit Ampacity: **<Insert value>**.

- f. Maximum Overcurrent Protection: **<Insert amperage>**.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Compression Tanks:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 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.
 4. Capacity and Characteristics:
 - a. Working-Pressure Rating: **150 psig**
 - b. Capacity Acceptable: [**2 gal. 4 gal. 7 gal. 10 gal**] **<Insert value>** minimum.
 - c. Air Precharge Pressure: **<Insert system pressure>**.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS ¾ 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[**or ASHRAE 90.2**].
- 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 [**calibrated**] [**memory-stop**] balancing valves to provide balanced flow through each domestic-water heater.
1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
 2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
- F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig maximum outlet pressure unless otherwise indicated.
- G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than 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 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "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 033000 "Cast-in-Place Concrete."**] [**Section 033053 "Miscellaneous 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 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
- C. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- D. 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.
- E. Install combination temperature-and pressure relief valves in water piping for electric, 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.
- F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- G. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- H. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- I. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- J. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of **25 psig** Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."

- K. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- L. Fill electric, domestic-water heaters with water.
- M. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. 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 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial electric, domestic-water heaters.

END OF SECTION

SECTION 22 4000
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section, and all sections of Division 22.

1.2 SUMMARY

- A. Requirements for plumbing fixtures. Plumbing fixture specifications are located on the contract drawings.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Section 22 05 00 - "Common Work Results for Plumbing."
 - 2. Section 22 05 03 - "Pipes and Tubes for Plumbing Piping and Equipment": Supply connections to plumbing fixtures.
 - 3. Section 22 05 23 - "General Duty Valves for Plumbing Piping:" Valve requirements.
 - 4. Section 22 25 01 - "Plumbing Piping Systems Cleaning and Treatment:" Requirements with regards to plumbing fixture installation and piping sterilization.
 - 5. Section 26 05 19 - "Low Voltage Electric Power Conductors and Cables": Requirements for electrical wiring and cable connections for sensor valves and faucets specified in this section.
 - 6. Section 26 05 33 - "Raceways and Boxes for Electrical Systems:" Requirements for conduits and boxes housing electrical wiring and connections for items specified in this section."

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

- A. American National Standards Institute:
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ANSI Z124.1 - Plastic Bathtub Units.
 - 3. ANSI Z124.2 - Plastic Shower Units.
 - 4. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.
- B. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.
- C. American Society of Mechanical Engineers:
 - 1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
 - 2. ASME A112.18.1 - Plumbing Fixture Fittings.
 - 3. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
 - 4. ASME A112.19.2M - Vitreous China Plumbing Fixtures.

5. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
6. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
7. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.

1.4 SUBMITTALS

- A. General – Submit each item in this section according to the conditions of the Contract and Division 01 specifications sections.
- B. Product Data: Submit catalog illustrations of fixtures, sizes, [rough-in dimensions,] utility sizes, trim, and finishes.
- C. Manufacturer's Installation Instructions: Submit installation methods and procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Provide Closeout documentation in accordance with execution and closeout requirements of the Contract and Division 01 specification sections.
- B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with all applicable codes, standards, and local authorities having jurisdiction requirements.
- B. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc., and/or a testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.
- C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 50 miles of Project.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience, approved by manufacturer and with service facilities within 50 miles of project.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.9 WARRANTY

- A. Furnish five year manufacturer warranty for plumbing fixtures.

1.10 EXTRA MATERIALS

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) 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.
- 3) Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
- 4) Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
- 5) Water-Closet Tank, Repair Kits: Equal to 5 percent of amount of each type installed.
- 6) Toilet Seats: Equal to 5 percent of amount of each type installed.
- 7) Dry Urinal Trap-Seal Cartridges: Equal to 200 percent of amount of each Dry Urinal Trap-Seal Liquid: Equal to 1 gal for each urinal installed.

1.11 DEFINITIONS

- A. Lead Free:

1. The pipes, pipe fittings, plumbing fittings or fixtures in plumbing systems that are intended to dispense potable water for human consumption, including drinking and cooking, shall be "lead free", containing not more than a weighted average of 0.25% lead with respect to the wetted surfaces.
2. Solder and flux for soldered joints in potable water piping shall be "lead free", containing not more than 0.2% lead free

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

- A. Furnish and install all fixtures and trim necessary to complete fixture installation. Provide approved stop valve, to match fittings, on both hot and cold water supplies to each fixture, all fixtures requiring hot and cold water shall have cold water faucets on right and hot water faucets on left. Exposed metal work shall be chrome plated red brass. Fixtures shall be white, unless otherwise specified. (Note: The "P" identification symbol with each fixture identified type shown on drawings.) Where fixtures tailpieces, traps and stop valves are not indicated, same shall be provided to suit fixture.
- B. Coordinate flush valve mounting heights for all water closets with the locations of grab bars; refer to Architectural Contract Drawings for exact grab bar locations.
- C. Refer to Architectural Drawings for mounting heights of all fixtures.
- D. All exposed bolts, screws, fasteners, etc. shall be vandal proof.
- E. Utilize Sani-Sett setting compound for fixtures.

- F. All plumbing materials, equipment and fixtures shall be new and of best grade, free of defects and complete with all required appurtenances and accessories.
- G. Provide supports necessary to adequately and substantially hang and set fixtures. Supports shall be Zurn, Josam or J.R. Smith and shall be suitable for wall types and thicknesses and piping arrangements shown.
 - 1. Wall mounted, urinal supports, Zurn ZR-1222 plate type with cast iron headers, box steel stanchions, block type cast iron feet with bearing plate.
 - 2. Support for wall mounted, urinals, lavatories, sinks, water coolers, etc.:
 - a. Where fixtures are supported from concrete or cinder block walls, install No. 10 USSG steel plate on the opposite side of the wall and bolt hangers or supports through plate. Where opposite side of wall is exposed to view, place bolts in core of blocks and fill core with cement.
 - b. Where lavatories with wall hangers have been specified and fixtures are supported from metal stud frame partitions, fixture brackets or mounting lugs shall be through bolted to steel channel crosspieces not less than 1 1/2" wide anchored to studs. Bolt heads shall be welded to channel web.
 - c. Concealed arm type lavatory supports, Zurn ZR-1231 with cast iron headers, box steel stanchions, block type cast iron feet and header and chrome plated cast brass threaded escutcheons for slab type lavatories.
 - 3. Wall mounted water closet chair carriers, Zurn Z-1203 Series for horizontal installation.
- H. Plumbing fixtures shall be caulked at walls and floors with silicone caulking material of same color as fixture(s).
- I. Locate countertop sinks and/or under counter sinks furnished under this Division. Furnish templates to the countertop fabricator for cutting of required holes.
- J. For sinks and fixtures specified under other divisions or other contracts and not provided with faucets, tailpieces, traps, stop valves and supply tubes, provide necessary fittings and completely connect the sinks and fixtures.
- K. Where sensor operated flush valves and faucets are specified hereinafter, furnish transformer(s) to serve the maximum recommended number of fixtures per the fixture manufacturer's recommendations. Each transformer shall be suitable for a 120v primary voltage. Wiring shall be installed under Division 26.
- L. Hot and cold water connections to fixtures shall be provided with a stop valve, stop valves, risers, etc. Stop valves and risers shall be light commercial grade: as manufactured by Brasscraft, Central Brass or an acceptable comparable product. Commercial/Institutional grade: as manufactured by Chicago Faucet, Brass Craft, McGuire or an acceptable comparable product.
- M. Refer to contract drawings for additional plumbing fixture specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to Division 01 Specifications for Coordination and project conditions.
- B. Verify walls and floor finishes are prepared and ready for installation of fixtures.

- C. Verify electric power is available and of correct characteristics.
- D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- A. Install Work in accordance with all applicable codes, standards, and local authorities having jurisdiction requirements.
- B. Install each fixture with trap, easily removable for servicing and cleaning.
- C. Provide chrome plated rigid or flexible supplies to fixtures with loose key or screwdriver stops, reducers, and escutcheons.
- D. Install components level and plumb.
- E. Install and secure fixtures in place with wall supports or wall carriers and bolts as recommended by fixture manufacturer.
- F. Seal fixtures to wall and floor surfaces with Sani Sett setting compound. Color to match fixture.
- G. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.
- H. For ADA accessible water closets, install flush valve with handle to wide side of stall.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.5 ADJUSTING

- A. Refer to Division 01 Specifications for execution requirements for Testing, adjusting, and balancing requirements.
- B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- A. Refer to Division 01 specifications for final cleaning requirements.
- B. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

- A. Refer to Division 01 Specifications for protecting installed construction.

- B. Do not permit use of fixtures before final acceptance.

3.8 SCHEDULES

- A. Refer to contract drawings for plumbing fixture schedule.
- B. Fixture Rough-in: Refer to plumbing fixture schedule on contract drawings.

END OF SECTION

SECTION 22 4700

DRINKING FOUNTAINS AND 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. This Section includes the following water coolers and related components:
 - 1. Pressure water coolers.

1.3 DEFINITIONS

- A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of fixture.
- C. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
- D. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS

- A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
- B. Operation and Maintenance Data: For fixtures 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.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act" ; and Public Law 101-336, "Americans with Disabilities Act" ; for fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

- D. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- E. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

- A. Water Coolers, DF-1:
 - 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:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 3. 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. Elkay Manufacturing Co.
 - b. Halsey Taylor.
 - c. Haws Corporation.
 - d. Larco, Inc.
 - e. Oasis Corporation.
 - f. Sunroc Corp.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Use mounting frames for recessed water coolers, unless otherwise indicated.
- B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

- A. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- B. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to 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 Division 22 Section "General-Duty Valves for Plumbing Piping."
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
 - 1. Remove and replace malfunctioning units and retest as specified above.
 - 2. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

3.7 CLEANING

- A. After completing fixture installation, 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.

END OF SECTION

SECTION 23 0500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 23.

1.2 SUMMARY

- A. Section Includes:
 - 1. General administrative and procedural requirements, as well as the following basic mechanical materials and methods.
 - 2. Submittals.
 - 3. Coordination drawings.
 - 4. Record documents.
 - 5. Operation and Maintenance manuals.
 - 6. Rough-ins.
 - 7. Mechanical installations.
 - 8. Cutting and patching.
 - 9. Concrete equipment base construction requirements.
 - 10. Equipment nameplate data requirement.
 - 11. Labeling and identifying mechanical systems and equipment is specified in Section 23 05 53 - "Identification for HVAC Piping and Equipment."
 - 12. Non-shrink grout for equipment installations.
 - 13. Field-fabricated metal and wood equipment supports.
 - 14. Installation requirements common to equipment specification Sections.
 - 15. Mechanical demolition.
 - 16. Touchup painting and finishing.

1.3 ACRONYMS

- A. The following list of abbreviations are utilized within the specifications and are provided as a reference:

| | | |
|--------|---|---|
| AABC | - | Associated Air Balance Council |
| ADA | - | American Disability Act |
| ADC | - | Air Diffusion Council |
| AGA | - | American Gas Association |
| AMCA | - | Air Moving and Conditioning Association |
| ANSI | - | American National Standards Institute |
| ARI | - | Air Conditioning and Refrigeration Institute |
| ASHRAE | - | American Society of Heating, Refrigerating and Air Conditioning Engineers |
| ASME | - | American Society of Mechanical Engineers |
| ASTM | - | American Society for Testing and Materials |
| AWS | - | American Welding Society |
| AWWA | - | American Water Works Association |
| BOCA | - | Building Officials and Code Administrators |
| CS | - | Commercial Standard |

| | | |
|--------|---|--|
| IBR | - | Institute of Boiler and Radiator Manufacturers |
| IEEE | - | Institute of Electrical and Electronics Engineers |
| IMC | - | International Mechanical Code |
| IPC | - | International Plumbing Code |
| MSSP | - | Manufacturers Standards Society of the Valve and Fittings Industry |
| NEC | - | National Electrical Code |
| NEMA | - | National Electrical Manufacturers Association |
| NFPA | - | National Fire Protection Association |
| OSHA | - | Occupational Safety and Health Administration |
| SMACNA | - | Sheet Metal and Air Conditioning Contractors National Association |
| TEMA | - | Tubular Exchanger Manufacturers Association |
| UL | - | Underwriters' Laboratories |

1.4 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term product includes the terms material, equipment, system, and terms of similar intent.
1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes proposed by Contractor in products, materials, equipment, and methods of construction required by the Contract Documents.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named, or a product is accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.
- D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
- E. Extended Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.5 SYSTEM DESCRIPTION

- A. Design Requirements: Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required.
 - 1. Furnish and install all items as may be required at no additional cost to fit the work to the conditions encountered.
 - 2. Arrange piping, ductwork, equipment and other work generally as shown on the contract drawings, providing proper clearances and access.
 - 3. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawing submittal for approval in accordance with Submittals specified below.
 - 4. Subject to the provisions of Division 1, Architect may make reasonable changes in location of equipment piping and ductwork up to the time of rough-in or fabrication.

1.6 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the contract and Division 01 Specification Sections.
- B. Comply with the Division 01 specifications.
- C. Shop Drawings and Product Data:
 - 1. Clearly identify all submittals:
 - a. Indicate intended application, location, etc.
 - b. Each submittal shall indicate the associated specification section, and paragraphs. Do not combine product data and shop drawing submittals from different spec sections into a single submittal package, even though they may be the same distributor, vendor or part of a single material order.
 - c. Clearly indicate the exact type, model number, size and special features of the proposed item.
 - d. Include catalog spec sheets to completely describe proposed equipment.
 - e. Factory order forms only showing the required capacities are not acceptable.
 - f. Identify all options furnished to meet specifications.
 - g. The Architect shall not select equipment ratings and/or options. Submittals not properly marked shall be returned without review.
- D. Product Substitutions: Comply with requirements of the Division 01 Specifications.
- E. Comparable Products Submission:
 - 1. Document each request for a proposed comparable product with supporting data substantiating compliance of proposed product with Basis-of-Design product.
 - 2. Use the attached "Comparable Product Submittal Form" in addition to the requirements specified herein.
 - 3. Comparable products will not be reviewed without completion of the attached form.
- F. Coordination Drawings
 - 1. Prepare coordination drawings to a scale of 1/4" = 1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in

relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

- a. Indicate the proposed locations of piping, valving, ductwork, equipment, and materials. Include the following:
- b. Planned piping layout, including valve and specialty locations and valve stem movement.
- c. Planned duct systems layout, including elbow radii and duct accessories.
- d. Clearances for installing and maintaining insulation.
- e. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
- f. Equipment connections and support details.
- g. Exterior wall and foundation penetrations.
- h. Fire-rated wall and floor penetrations.
- i. Sizes and location of required concrete pads and bases.
- j. Duct fire dampers.
- k. Access doors.
- l. Clearances at electrical components in accordance with the National Electric Code.
- m. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- n. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. Show all wall mounted access doors for mechanical devices.
- o. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, cable trays, sprinklers, access doors and other ceiling mounted items.
- p. Coordination drawings shall at a minimum include coordination with Division, 21, Division 22 and Division 26 installers. Include fire protection piping, domestic water piping (cold water, hot water and hot water re-circulation), natural gas piping sanitary piping, sanitary vent piping, closed loop supply and return piping, ductwork, flexible duct, ceiling mounted air devices, lights, ceiling and building structural members (floor slabs, beams, joists, etc.). Coordination drawings shall be provided at a minimum for:
 - 1) First Floor Corridor. Provide floor plans and at least two sections.
 - 2) Commercial kitchen piping and ductwork layout. Provide floor plans and at least two sections.
 - 3) All Mechanical Rooms. Provide floor plans and at least two sections for each.
 - 4) Garage ductwork and piping layout. Provide floor plans and at least two elevations. Indicate inverts of all piping and ductwork crossing drive aisle.
- q. Submit ductwork fabrication drawings.

G. Closeout Submittals:

1. Record Drawings: Prepare record documents in accordance with the requirements in the Division 01 Specifications. In addition to the requirements specified in Division 01, indicate the following installed conditions:
 - a. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes,

- and terminal units requiring periodic maintenance or repair.
 - b. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Section 23 05 53 - "Identification for HVAC Piping and Equipment." Indicate actual inverts and horizontal locations of underground piping.
 - c. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - d. Approved substitutions, Contract Modifications, Responses to Contractor's Request for Information, and actual equipment and materials installed.
 - e. Record the locations and invert elevations of underground installations.
2. Operation and Maintenance Data: Prepare operation and maintenance data in accordance with the Division 01 Specifications. In addition to the requirements specified in Division 01, include the following information for equipment items:
- a. List of systems and equipment requiring service manuals.
 - b. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - c. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - d. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - e. Servicing instructions and lubrication charts and schedules.
 - f. Systems and Equipment test reports.
- H. Color Selection: Color of finishes shall be as selected by the Architect. Submit colors of factory finished equipment for acceptance prior to ordering.
- I. Products and Materials:
1. Submit complete descriptive data for all materials as follows:
 - a. Material specifications.
 - b. Data sheets.
 - c. Samples.
 - d. Capacity ratings.
 - e. Performance curves.
 - f. Operating characteristics.
 - g. Catalog cuts.
 - h. Dimensional drawings.
 - i. Wiring diagrams.
 - j. Installation instruction.
 - k. Any other information necessary to indicate compliance with contract documents.
 2. Edit submittal data specifically for application to this project.
 3. Submit actual operating conditions and characteristics for all equipment.
 4. Catalogs or catalog cuts are not acceptable unless the particular item and all relative data has been marked in such a manner as to be clearly defined.
 5. Color of finishes shall be as selected by the Architect. Submit colors of factory finished equipment for acceptance prior to ordering.
 6. No mechanical item shall be fabricated, purchased, delivered to the site or

installed, until reviewed by the Architect.

- a. After the proposed materials have been approved, no substitution will be permitted except where approved by the Architect.
7. Provide shop drawing and product data submittals as indicated under individual specification sections.
8. Provide any other equipment requested by the Architect.

1.7 QUALITY ASSURANCE

- A. Underwriter's Laboratory (UL) Requirements: All equipment containing electrical components and provided under Division 23 shall bear the Underwriter's Laboratory (UL) label, as a complete packaged system.
 1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a listed label at the installer's expense.
 - a. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.
 - b. Provide services of a UL recognized, independent Electrical Testing Laboratory (ETL) to provide field inspection and testing. Provide and ETL Label on all such equipment.
- B. Fire Safe Materials: Unless otherwise indicated, materials shall conform to UL, National Fire Protection Agency (NFPA) or American Society for Testing and Materials (ASTM) standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the Division 01 Specifications and the requirements contained herein.
 1. Deliver, store, and handle products according to manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
 2. Schedule delivery to minimize long-term storage at Project Site and to prevent overcrowding of construction spaces.
 3. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 4. Deliver products to Project Site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 5. Inspect products upon delivery to ensure compliance with Contract Documents and to ensure that products are undamaged and properly protected.
 6. Store products in manner that will facilitate inspection and measurement.
 7. Store materials in a manner that will not endanger project structure.
 8. Store products subject to damage by elements above ground, under cover in a weather tight enclosure, with ventilation adequate to prevent condensation.
 9. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather protection requirements for storage.

1.9 PROJECT CONDITIONS

- A. Outages
 1. All mechanical outages which will interfere with the normal use of the building in

any manner shall be done at such times as shall be mutually agreed upon with the Owner.

2. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled with the Owner at least fourteen days (14) days in advance. All such outages shall be coordinated with the owner in writing. The owner reserves the right to partially occupy the building. Provide all necessary bypasses, isolation valves and dampers and other means and methods to limit the amount of time the building is without services.
3. The bid price shall include the cost of all premium time required for outages and other work which interferes with the normal use of the building.
4. The operation of valves or switches required to achieve an outage shall be accomplished by the Contractor in the Owner's presence. Unauthorized operation of valves, power switches, or other control devices shall not be permitted.

1.10 SEQUENCING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
- E. Coordinate connection of electrical services.
- F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- G. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces.
- H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1.11 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
 1. Manufacturer's Standard Form: Modified to include project-specific information and properly executed.

2. Refer to Divisions 02 through 26 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in the Division 01 Specifications.

1.12 DISCREPANCIES

- A. Where discrepancies occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quantity or higher cost shall be included in the contract price. The Architect shall decide on the item and manner in which the work shall be provided, based on the design intent of the documents.

1.13 ELECTRONIC CAD DOCUMENTS

- A. Requests for electronic CAD documents will be accommodated to the contractors and installers upon their completion of Given and Associates electronic document release of liability form and payment for time and expense for document preparation.
 1. Given and Associates document preparation fee is as follows:
 - a. Two hundred and fifty dollars (\$250.00) for the first five (5) drawings.
 - b. Fifty dollars (\$50.00) for each drawing thereafter.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

- A. General Product Requirements: Provide products that comply with Contract Documents that are undamaged and new at time of installation.
 1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for complete installation and intended use and effect.
 2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Where products are accompanied by the term as selected, Architect will make selection.
 4. Where products are accompanied by the term match sample, sample to be matched is Architect's.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. General Compliance Requirements: Compliance requirements for individual products, as indicated in Contract Documents, are multiple in nature and may include generic descriptions, performance requirements, compliance with reference standards, conformance with graphic details and other similar forms and methods of indicating requirements, all of which must be complied with.
- C. Procedures for Selecting Products: Contractor's options for selecting products are limited by Contract Document requirements, and are not controlled by industry traditions or procedures experienced by Contractor on previous construction projects.
- D. Products specified by Reference Standards, Codes and Regulations: Select from among products, which can be shown to comply with referenced documents.
- E. Products specified by Naming Products and Manufacturers: Select from among products listed.

- F. Products specified by Naming One Manufacturer's Product as the Basis-of-Design with Reference to Other Manufacturers: Select either the specified Basis-of-Design product or an approved comparable product by one of the other named manufacturers.
 - 1. Comply with provisions in Comparable Products Article to obtain approval for use of a comparable product by one of the named manufacturers.
- G. Products specified by Naming One Manufacturer's Product and Indicating Option of Selecting Comparable Products by stating or Approved Equivalent or similar language: Select either the specified product or an approved comparable product.
 - 1. Comply with provisions in Comparable Products Article to obtain approval for use of a comparable product by one of the named or un-named manufacturers.
- H. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and, matches Architect's sample. Architect's decision will be final on whether proposed product matches satisfactorily.
- I. Visual Selection Specification: Where Specifications include the phrase as selected from manufacturer's standard colors, patterns, textures or similar phrase, select a product that complies with other specified requirements. Architect will select color, pattern, and texture.
 - 1. Standard Range: Where Specifications include the phrase standard range of colors, patterns, textures or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that does not include premium items.
 - 2. Full Range: Where Specifications include the phrase full range of colors, patterns, textures or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Where Basis-of-Design products are specified by name, submit the following, in addition to other required submittals, to obtain approval of a comparable product by one of the named manufacturers:
 - 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work. Use the attached Comparable Products Submittal Form in addition to requirements listed herein
 - 2. Detailed comparison of significant qualities of proposed product with the Basis-of-Design product in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, serviceability, visual effect, and specific features and requirements indicated.
 - 3. Evidence that proposed product provides specified warranty.
 - 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 - 5. Samples, if requested.

2.3 GROUT

- A. Non-shrink, Nonmetallic Grout: ASTM C 1107, Grade B, "Packaged Dry, Hydraulic-Cement Grout (Non-shrink)", 2001.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.50MPa), 28-day compressive strength.
3. Packaging: Premixed and factory-packaged.

2.4 ACCESS DOORS AND PANELS

- A. Provide manufactured steel door assemblies consisting of:
 1. Hinged door.
 2. Flush screwdriver camlocks and frame.
- B. Doors shall be Milcor Metal Access doors. Provide key locks where indicated.
- C. Design shall be provided for the following installations:
 1. Masonry or Dry Wall: Style M.
 2. Hard Finish Plaster: Style AP.
 3. Fire rated dry wall ceilings: Style CFRAD, 1 hour combustible floor ceiling system, 1 hour non-combustible floor ceiling system, 3 hour non-combustible floor ceiling system.
 4. Suspended ceilings: Style CT.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Interface With Site Utility Companies:
 1. Contact MISS UTILITY prior to any excavation or underground work.
 2. Contact local utility companies (gas, water, sewer, etc.) immediately upon award of contract. Do not install related equipment until fully coordinated with appropriate utilities.
 3. Provide all construction schedules, dates of requested services, outage windows, equipment locations, etc. necessary for utility work.

3.2 INSTALLATION

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
 1. Coordinate mechanical systems, equipment, and materials installation with other building components.
 2. Verify all dimensions by field measurements.
 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 6. Where systems, materials and equipment are intended for overhead installation, and where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
11. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 08
12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

B. Rough-In

1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
2. Refer to equipment specifications in Divisions 02 through 26 for rough-in requirements.

C. Housekeeping and Equipment Pads

1. Construct pads of dimensions indicated, but not less than 4 inches (100 mm) larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi (20.70MPa), 28-day compressive strength concrete and reinforcement bars. Refer to Division 03 Specifications for additional requirements.

D. Erection of Metal Supports and Anchorage

1. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
2. Field Welding: Comply with AWS D1.1, "Structural Welding Code -Steel", 2001.

E. Erection of Wood Supports and Anchorage

1. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.
2. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

F. Grouting

1. Install nonmetallic non-shrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout

-
2. according to manufacturer's printed instructions.
2. Clean surfaces that will come into contact with grout.
3. Provide forms for placement of grout, as required.
4. Avoid air entrapment when placing grout.
5. Place grout to completely fill equipment bases.
6. Place grout on concrete bases to provide a smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout according to manufacturer's printed instructions.

G. Lintels

1. Lintels shall be provided for openings in masonry, brick, concrete, etc. walls to accommodate work of this division.
 - a. Lintels shall be provided under this division when not being provided under other divisions. Lintels shall be approved by the Architect.

3.3 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 01 Specifications. In addition to the requirements specified in Division 1, the following requirements apply:
1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
1. Uncover Work to provide for installation of ill-timed Work.
 2. Remove and replace defective Work.
 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 4. Remove samples of installed Work as specified for testing.
 5. Install equipment and materials in existing structures.
 6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.
- C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, ductwork, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

3.4 PAINTING AND FINISHING

- A. Refer to Division 09 Specifications.
- B. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Do not paint manufacturer's labels or tags.

3.5 CONSTRUCTION

A. Cutting, Welding, Burning

1. If required, before commencing any cutting, welding, burning, brazing (pipe sweating), obtain a hot work permit from Environmental Health and Safety.
2. If required, the hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

3.6 PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.
- B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.7 EXCAVATION AND BACKFILLING

A. General

1. Perform all necessary excavation, for installation of work under Division 23, in accordance with Division 02.

3.8 CLEANING

- A. Clean surfaces prior to application of insulation, adhesives, coating, and paint.
- B. Provide factory applied finish where specified.
- C. Protect all finishes, and restore all finishes to their original condition if damaged as a result of work under Division 23.
- D. Remove all construction marking and writing from exposed equipment, ductwork, piping \ and building surfaces.
- E. General: General cleaning during construction is required by the General Conditions and included in Section Temporary Facilities.
- F. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
- G. Remove all mechanical clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.9 PROTECTION

- A. Protect work, material and equipment from weather and construction operations before and after installation.
- B. Properly store and handle all materials and equipment.

- C. Cover temporary openings in piping, ductwork and equipment to prevent the entrance of water, dirt, debris, and other foreign matter.

3.10 LUBRICATION

- A. All bearings, motors and all equipment requiring lubrication shall be provided with accessible fittings.
- B. Before turning over the equipment to the Owner, provide the following:
 - 1. Fully lubricate each item of equipment.
 - 2. Provide 1 year's supply of lubricant for each type of lubricant.
 - 3. Provide complete written lubricating instructions, together with diagram locating the points requiring lubrication.
- C. Motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal extended grease fittings and drain plugs.

3.11 ELECTRICAL WORK

- A. It is the intent to provide a complete and operational system. The work between Division 23 and 26 is complementary and is meant to produce a single and operating system. Contractor shall make its own determination as to the distribution of responsibility among the various trades.
- B. All electrical work performed under Division 23 shall be provided in accordance with Division 26.

3.12 PROVISIONS FOR ACCESS

- A. Furnish and install adequate access to all HVAC and plumbing components. The following list shall be used as a guide only:
 - 1. Mechanical equipment.
 - 2. Valves.
 - 3. Dampers and operators.
 - 4. Filters.
 - 5. Heating and air conditioning units.
 - 6. Controls.
 - 7. Cleanouts.
 - 8. Traps.
 - 9. Automatic temperature control panels.
 - 10. Coils.
- B. Access shall be adequate as determined by the Architect.
- C. Refer to contract drawings where panels have been specifically located.
- D. Provide additional panels for adequate access as indicated in paragraph A above.
- E. Where access is by means of liftout ceiling tiles or panels mark each panel using small color-coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.13 OPERATION OF EQUIPMENT

- A. Clean all systems and equipment prior to initial operation for testing and balancing.
- B. Do not operate equipment unless all proper safety devices or controls are operational.
- C. Provide all maintenance and service for equipment, which is operated during construction.
- D. Where specified and otherwise required, provide the services of a manufacturer's factory trained service organization to start the equipment.
- E. Do not use mechanical systems for temporary services during construction unless authorized in writing by the Architect.
 - 1. Where such authorization is granted, temporary use of equipment shall not limit or otherwise affect warranties or guarantees of the work.
- F. Upon completion of work, clean and restore all equipment to new conditions and replace all filters.

3.14 DEMONSTRATION

- A. Demonstrate operation and maintenance of equipment and systems to Owner's personnel a minimum two (2) weeks prior to date of final inspection.
 - 1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
 - 2. Training period shall be performed within 1 - two week period.
- B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.
- C. Demonstrate the following:
 - 1. Start up.
 - 2. Operation.
 - 3. Control.
 - 4. Adjustment.
 - 5. Trouble shooting.
 - 6. Servicing.
 - 7. Maintenance.
 - 8. Shutdown.
- D. Provide at least 40 hours straight time instruction to the operating personnel.
 - 1. This instruction period shall consist of not less than five-8 hour days.
 - 2. Time of instruction shall be designated by the Owner.
 - 3. This instruction shall be in addition to instructional requirements of specific equipment specified elsewhere in Division 23.
 - 4. Record all instruction periods. Provide the owner with three copies of the recordings in digital versatile disk (DVD) format.

3.15 WALL AND FLOOR PENETRATION

- A. All penetrations of partitions, walls and floors by ducts, piping or conduit under Division 23 shall be sealed and caulked. Provide U.L. listed fire stopping systems at penetrations through fire rated walls.

3.16 EQUIPMENT PROVIDED UNDER ANOTHER DIVISION AND BY OTHERS

- A. Make all system connections required to equipment furnished and installed under another division and by others.
- B. It shall be the responsibility of the Contractor to coordinate all necessary data from the equipment supplied under other Divisions.

3.17 PROJECT PUNCH OUT

- A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/ Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement will be made by deducting the Architect/Engineer fee from the Contractor's final payment.

3.18 AS-BUILT DRAWINGS

- A. Provide separate as-built drawings and record documents of all fire protection systems as required hereinbefore in this section.

COMPARABLE PRODUCT SUBMITTAL FORM

Table of Compliance (Sample)
Shop Drawing and Product Data Submittal

The Contractor shall prepare a Table of Compliance Form similar in format to the sample shown below to facilitate and expedite the Shop Drawing and Product Data Review. Failure to comply with this requirement will be basis for rejecting the Submittal.

The Table of Compliance Form will list and compare the performance parameters as the submitted equipment to that listed on equipment schedule and specifications as basis of design. All non-compliance items (differences) must be explained in full, indicating their impact, if any, on maintainability, durability, energy use, operating costs, code compliance and environmental considerations.

(Sample)
TABLE OF COMPLIANCE

EQUIPMENT: _____ SPEC. SECTION: _____

| BASIS OF DESIGN SAMPLE ITEMS | DRAWINGS | SUBMITTED | EXPLANATION |
|--|----------|-----------|-------------|
| Flow (Cfm Or Gpm) | | | |
| Ext. Static Press. | | | |
| Head (Ft.) | | | |
| Electrical Requirements | | | |
| Cooling Capacity | | | |
| Heating Capacity | | | |
| Discharge Air Temp. | | | |
| Filter Type & Eff. | | | |
| Equipment Eff. (Eer) | | | |
| Sound Data | | | |
| Weights | | | |
| Etc. | | | |
| Specifications: | | | |
| A. Quality assurance compliance (ARI) | | | |
| (ASHRAE) | | | |
| (AMCA) | | | |
| (UL) | | | |
| B. Specifications: List each and every specification paragraph | | | |
| C. Etc. | | | |
| Other: | | | |

END OF SECTION

SECTION 23 0514

COMMON MOTOR REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section, and all sections of Division 23.

1.2 SUMMARY

- A. Section includes:
 - 1. Motor requirements for all plumbing and HVAC equipment.
 - 2. Source Quality Control.
 - 3. Bearing Protection Ring.
 - 4. Motors that are factory installed as part of equipment and appliances as well as field installed motors.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Section 22 05 00 - "Common Work Results for Plumbing."
 - 2. Section 23 05 00 - "Common Work Results for HVAC."
 - 3. Section 22 05 53 - "Identification for Plumbing Piping and Equipment."
 - 4. Section 23 05 53 - "Identification for HVAC piping and Equipment."
 - 5. Section 22 10 01 - "Plumbing Pumps."
 - 6. Section 23 34 00 - "HVAC Fans."
 - 7. Section 23 81 46 - "Water-Source Heat Pumps."

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings, 1990 (R2000).
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators, 2006.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing, 2007.

1.4 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience.
- B. Testing Agency: Company who is a member of the International Electrical Testing Association and specializing in testing products specified in this section with minimum five years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- B. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- C. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR MOTORS

- A. General: Requirements below apply to motors covered by this Section except as otherwise indicated.
 - 1. Motors Larger than 1/2 HP: 3-phase.
 - 2. Motors 1/2 HP and Smaller: Single-phase.
 - 3. Frequency Rating: 60 Hz.
 - 4. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):
 - a. 120 V Circuit: 115 V - motor rating.
 - b. 208 V Circuit: 200 V - motor rating.
 - c. 240 V Circuit: 230 V - motor rating.
 - 5. Minimum service factor shall be 15% and shall apply at frequency and utilization voltage at which motor is connected. Provide motors, which will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.
 - 6. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity.
 - 7. Temperature Rise: Based on 40°C ambient except as otherwise indicated.
 - 8. Enclosure: Open drip proof, unless otherwise specified. Provide screen over slots, where slots will permit passage of human extremities.
 - 9. Provide adjustable motor slide base for belt driven equipment. Include adjusting bolts and locknuts.
- B. Three-phase Motors
 - 1. General: Squirrel-cage induction-type conforming to the following requirements except as otherwise indicated.

2. National Electrical Manufacturers Association NEMA Design Letter Designation: "B."
3. Multi-Speed Motors: Separate winding for each speed.
4. Minimum motor efficiencies shall be as follows:

| HP | Percent Efficiency, Minimum |
|---------------|-----------------------------|
| 1 and less | 84.0 |
| 1 ½ | 85.5 |
| 2 | 86.5 |
| 3 | 89.5 |
| 5 | 89.5 |
| 7 1/2 | 91.0 |
| 10 | 91.7 |
| 15 | 92.4 |
| 20 | 93.0 |
| 25 | 93.6 |
| 30 | 94.1 |
| 40 | 94.5 |
| 50 | 94.5 |
| 60 | 95.0 |
| 75 and larger | 95.4 |
5. Variable Speed Motors for Use With Solid-State Drives: Energy efficient, squirrel-cage induction, design B units and ratings, characteristics, and features coordinated with and approved by drive manufacturer. Motors shall be labeled to indicate that they are provided with inverter duty capability in accordance with the National Electrical Manufacturers Association NEMA MG-1, Part 31.
6. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading of the application. Provide bearings without plugs for grease fittings.
7. Motors for Reduced Inrush Starting: Coordinate with indicated reduced controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.
8. All motors shall be provided with manufacturer's stamped nameplate, to include all pertinent and capacity data.

C. Single-phase Motors

1. General: Conform to the following requirements except as otherwise indicated.
2. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application.
 - a. Permanent Split Capacitor.
 - b. Split-Phase Start, Capacitor-Run.
 - c. Capacitor-Start, Capacitor-Run.
3. Shaded-Pole Motors: Use only for motors smaller than 1/20 hp.
4. Internal Thermal Overload Protection for Motors: Protection shall automatically opens the power supply circuit to the motor, or a control circuit arranged for external connection. Protection operates when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.
5. Bearings: Belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

2.2 SOURCE QUALITY CONTROL

- A. Test motors in accordance with National Electrical Manufacturers Association NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

2.3 BEARING PROTECTION RING

- A. All motors driven by a variable frequency PWM drive shall include a maintenance free, circumferential, conductive micro fiber shaft grounding ring to discharge shaft currents to ground.
- B. Provide AEGIS SGR Bearing Protection Ring as manufactured by Electro Statix Technology.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: The following requirements apply to field-installed motors.
 - 1. Install motors in accordance with manufacturer's published instructions and the following:
 - a. Direct Connected Motors: Mount securely in accurate alignment. Connect to driven equipment with coupler of appropriate type and material for the given duty. Coupler shall be selected for high and range of motor application.
 - b. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with the International Electrical Testing Association - NETA ATS, 2007.

3.3 VARIABLE FREQUENCY MOTORS

- A. Install Bearing Protection Ring in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including the General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other Sections of Division 23.

1.2 SUMMARY

A. General Requirements

1. Incorporate in construction pipe hangers and supports to manufacturer's recommendations utilizing manufacturer's regular product components, parts, and assemblies.
2. Comply with maximum load ratings with considering for allowable stresses prescribed by ASME B31.1 or MS SP-58.
3. Provide support, guides and anchors that do not transmit unacceptable heat and vibration to building structure.
4. Installation of pipe hangers and supports shall be based upon the overall design concept of the piping system. The support system shall provide for and control the free movement of piping including its movement in relation to the connected equipment.
5. Provide for vertical adjustments after installation of supported material and during commissioning, where feasible, to ensure pipe is at design elevation and slope.

B. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Equipment curbs.
6. Sleeves.
7. Mechanical sleeve seals.
8. Formed steel channel.
9. Firestopping relating to HVAC work.
10. Firestopping accessories.
11. Equipment bases and supports.
12. Acoustical Sealant.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 23 05 00 - "Common Work Results for HVAC."
2. Section 23 05 48 - "Vibration and Seismic Controls for HVAC Piping and Equipment": Product and execution requirements for vibration isolators.
3. Section 23 07 00 "HVAC Insulation."
4. Section 23 05 03 - "Pipes and Tubes for HVAC Piping and Equipment": Execution requirements for placement of hangers and supports specified by this section.
5. Section 23 05 23 - "General Duty Valves for HVAC Piping."

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Method for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:

1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

1.4 DEFINITIONS

- A. Terminology used in this Section is defined in Manufacturer's Standardization Society Specification 90, "Valve and Fittings Standards," 2000.

1.5 SUBMITTALS

- A. General: Submit each item in this Section according to the Conditions of the Contract and Division 01 Specification Sections.

- B. Product data for each type of hanger and support, including load capacity.
- C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.
- F. Submit following in accordance with Conditions of Contract and Division 01 Specifications:
 - 1. Shop drawings of items.
 - 2. Complete description of products to be supplied including product data, dimensions materials of construction and specifications.
 - 3. Installation instructions for each product.
 - 4. Layout of piping and ductwork to be isolated including vertical risers showing:
 - a. Support points.
 - b. Weight at support points.
 - c. Isolator type.
 - d. Static deflection expected under actual load.
 - e. Specified static deflection.
 - f. Additional deflection to solid under actual load.
 - g. Ratio of spring height under load to spring diameter.
 - 5. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method and location of equipment attachment bolts.
 - 6. Special details at large scale and other necessary information to convey understanding of work.
- G. Submission of samples may be requested for each type of vibration isolation device. After approval, samples shall be returned for installation at job site.

1.6 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code - Steel," 2001.
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. NFPA Compliance: Comply with NFPA 13, "Installation of Sprinkler Systems," 1999, for hangers and supports used as components of fire protection systems.
- D. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70 "Definitions."
 - 1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.
- E. Licensed Operators: Use operators that are licensed by powder-operated tool

manufacturers to operate their tools and fasteners.

- F. Supply and install incidental materials needed to meet requirements, even if not expressly specified or shown on drawings without claim for additional payment.
- G. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Division 01 Specifications and requirements contained herein for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Refer to Division 01 Specifications for requirements regarding environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air are not in accordance with the manufacturer's installation procedures.
- C. Maintain manufacturer's required temperature before, during, and after installation of firestopping materials for minimum periods of time as required by the manufacturer.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, "Carbon Structural Steel," 2001, steel plates, shapes, and bars, black and galvanized.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, "Track Bolts and Nuts," 2000, steel, hex-head, track bolts and nuts.
- C. Washers: ASTM F 844, "Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use," 2005, steel, plain, flat washers.

- D. Grout: ASTM C 1107, Grade B, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)," 2001, non-shrink, nonmetallic.
 - 1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is non-staining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5MPa), 28-day compressive strength.
 - 3. Water: Potable.
 - 4. Packaging: Premixed and factory-packaged.

2.2 HANGERS AND SUPPORTS

- A. Hangers, Supports, and Components: Provide factory-fabricated products as manufactured by B-Line, Tyco – (Anvil Hangers), Pipe Shields, Inc., or Michigan Hanger. Basis of Design shall be B-Line.
 - 1. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
 - 2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Thermal-Hanger Shield Inserts: 100-psi (690kPa) average compressive strength, waterproofed calcium silicate or treated lumber inserts, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.
- D. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.
- E. Install rigid round and rectangular metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
- F. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
- G. Support vertical ducts at a maximum interval of 16 feet and at each floor.
- H. Upper attachments to structures shall have an allowable load not exceeding 3 of the failure (proof test) load but are not limited to the specific methods indicated.
- I. Horizontal Non-Insulated Copper Piping Hangers:
 - 1. Two inch and smaller: Figure No. B3104 CTC.
 - 2. Two and one-half inch and larger: Figure No. B3104 CT.
- J. Insulated Horizontal Piping Hangers: Refrigerant Piping:
 - 1. Two inch and smaller: Figure No. B3108 with metal shield, Figure No. B3151.
 - 2. Two and one-half inch and larger: Figure No. B3108 with metal shield, Figure No. B3151.

- K. Vertical Piping Riser Clamps:
 - 1. Copper Pipe: Figure No. B3373CT.
 - 2. Steel Pipe: Figure No. B3136 and B3137.
- L. Beam Clamps and Attachments:
 - 1. For bolt-on locations to structure, Figure Nos. B3291, B3036, or B3050.
 - 2. Welded beam attachments, Figure No. B3083.
- M. Concrete Inserts:
 - 1. For concrete spot inserts at single locations for casting into structure, Figure No. B3014 for pre- determined rod size and Figure No. B2500 for universal use.
 - 2. For continuous slot concrete insert at multi-locations for casting into structure, Figure No. B2505.
- N. Brackets:
 - 1. For equipment and piping adjacent to walls or steel columns, Figure Nos. B3066, B3063 and B3067 depending on weight to be supported.
- O. Pipe Rests:
 - 1. For pipes close to floor where no expansion provision is required, Figure No. B3088T base stand with B3093 adjustable pipe saddle support.
- P. Hanger Rods:
 - 1. Hanger rod, Figure No. B3205.
 - 2. Continuous threaded rod, Figure No. ATR.
 - 3. Eye rods, Figure No. B3210 or B3211, depending on load supported.
- Q. Trapeze Hangers - Direct Mounting Hangers:
 - 1. Grinnell, Figure No. 46.
- R. Protection Saddles:
 - 1. Cast iron pipe, insulated, Figure No. B3108 with metal shield, Figure No. B3151.
 - 2. For high temperature steel pipe, insulated, No. B3160, B3161, B3162, B3163, B3164, or B3165.
- S. Pipe Roll Stands:
 - 1. For support of pipe where axial movement is encountered: Figure No. B3117SL where no vertical adjustment is required; and Figure No. B3118SL where vertical adjustment is required.

2.3 ACOUSTICAL SEALANT

- A. Sealants for acoustical purposes shall be one of following non-setting sealants:

Acoustical sealant.....D.A.P.
BR – 96.....Pecra

Acoustical sealant.....Tremco
Acoustical sealantU.S.G.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material. Install damming material to arrest liquid material leakage.
- B. Remove incompatible materials affecting bond.
- C. Drilling or cutting of structural members shall be as detailed / directed by structural engineer.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Comply with MSS SP-69, "Pipe Hangers and Supports C Selection and Application," 1996, and SP-89, "Pipe Hangers and Supports -- Fabrication and Installation Practices," 1998. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. Piping shall be supported independently from equipment connections. Supports shall not interfere with removal of equipment.
- B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.
- C. Install supports with maximum spacings complying with MSS SP-69, "Pipe Hangers and Supports C Selection and Application," 1996, and as specified in Section 23 05 03 - "Pipes and Tubes for HVAC Piping and Equipment."
- D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
- E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69, "Pipe Hangers and Supports C Selection and Application," 1996. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts in new construction prior to placing concrete. Install reinforcing bars through openings at top of inserts.
- F. Install powder-actuated drive-pin fasteners 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. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100 mm) thick.
- G. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100 mm) thick.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36, "Carbon Structural Steel,"

2001, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1, "Structural Welding Code - Steel," 2001.

- J. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
- M. Insulated Piping: Provide continuous insulation and vapor barrier through hangers and supports. Comply with the following installation requirements.
 1. Riser Clamps: Attach riser clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9. Insulate clamps on piping with insulation and vapor barrier.
 2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
 3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees (3.1 rad) and have dimensions in inches (mm) not less than the following:

| NPS (Inches) | LENGTH (Inches) | THICKNESS (Inches) |
|--------------|-----------------|--------------------|
| 1/4 to 3 1/2 | 12 | 0.048 |
| 4 | 12 | 0.060 |
| 5 and 6 | 18 | 0.060 |
| 8 to 14 | 24 | 0.075 |

4. Pipes 4 Inches (200 mm) and Larger: Include treated wood inserts.
5. Insert Material: Length to equal to the length of the protective shield.
6. Conform to the table below for maximum spacing of supports and rod sizes:
7. Steel and Copper Pipe:

| Nom. Pipe Size – In. | Steel Pipe Max. Span – Ft. | Copper Tube Max. Span – Ft. | Min. Rod Dia. – In. |
|----------------------|----------------------------|-----------------------------|----------------------|
| Up to 3/4 | 7 | 5 | 3/8 |
| 1 | 7 | 6 | 3/8 |
| 1 1/4 | 7 | 7 | 3/8 |
| 1 1/2 | 9 | 8 | 3/8 |
| 2 | 10 | 8 | 3/8 |
| 2 1/2 | 11 | 9 | 1/2 |
| 3 | 12 | 10 | 1/2 |
| 3 1/2 | 13 | 11 | 1/2 |
| 4 | 14 | 12 | 5/8 (1/2 for copper) |
| 5 | 16 | 13 | 5/8 (1/2 for copper) |
| 6 | 17 | 14 | 3/4 (5/8 for copper) |
| 8 | 19 | 16 | 3/4 (3/4 for copper) |
| 10 | 22 | 18 | 3/4 (3/4 for copper) |

12

23

19

3/4 (3/4 for copper)

- a. Support vertical steel pipe and copper tube at each floor.

N. Equipment Supports:

1. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
2. Grouting: Place grout under supports for equipment and concrete bases. Make a smooth bearing surface.
3. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 4" beyond supported equipment.
4. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

O. Metal Fabrication:

1. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.
2. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
3. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:
 - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - b. Obtain fusion without undercut or overlap.
 - c. Remove welding flux immediately.
 - d. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.3 FIELD QUALITY CONTROL

- A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.4 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.5 PROTECTION OF FINISHED WORK

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

3.6 APPLICATIONS FOR HANGER AND SUPPORT

- A. Specific hanger requirements are specified in the Section specifying the equipment and systems.
- B. Comply with MSS SP-69, "Pipe Hangers and Supports C Selection and Application," 1996, for pipe hanger selections and applications that are not specified in piping specification Sections.

3.7 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to

achieve indicated slope of pipe.

- B. Adjust for pipe alignment and final equipment connections. Flexible connections shall not be used for adjustment of alignment.

END OF SECTION

SECTION 23 0548

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including the General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other Sections of Division 23.

1.2 SUMMARY

- A. This Section includes vibration control for mechanical systems piping and equipment.
- B. All HVAC components mounted outside of the building envelope (on-grade, on roof, on exterior walls, etc.) shall be mounted and supported to resist wind loads as required by the International Building Code (IBC), edition in effect by local authority having jurisdiction.
- C. Section Includes:
 - 1. Inertia bases.
 - 2. Vibration isolators.
 - 3. Duct silencers.
 - 4. Cross-talk silencers.
 - 5. Acoustic housings.
 - 6. Ductwork lagging.
 - 7. Acoustical louvers.
- D. Related Sections:
 - 1. Section 23 05 00 - "Common Work Results for HVAC."
 - 2. Section 23 07 00 - "HVAC Insulation."
 - 3. Section 23 05 03 - "Pipes and Tubes for HVAC Piping and Equipment."
 - 4. Section 23 05 16 - "Expansion Fittings and Loops for HVAC Piping": Product requirements for anchors and piping expansion compensation.
 - 5. Section 23 05 29 - "Hangers and Supports for HVAC Piping and Equipment": Product requirements for pipe hangers and supports.

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- B. American National Standards Institute:
 - 1. ANSI S1.4 - Sound Level Meters.
 - 2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
 - 3. ANSI S1.13 - Methods for the Measurement of Sound Pressure Levels in Air.
 - 4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of

Noise Sources.

- C. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.
- D. ASTM International:
 - 1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - 2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- E. International Building Code (IBC)
- F. ASCE-7, Minimum Design Loads for Buildings and Other Structures

1.4 DEFINITIONS

- A. Terminology used in this Section is defined in Manufacturer's Standardization Society Specification - 90, "Valve and Fittings Standards," 2000.
- B. Life Safety Systems:
 - 1. All systems involved with fire dampers and smoke damper systems.
 - 2. All HVAC systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flowpaths to fire protection.
- C. Positive Attachment:
 - 1. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead ductwork, hydraulic piping, bus duct, or any other equipment are not acceptable on this project.
- D. Transverse Bracing:
 - 1. Restraint(s) applied to limit motion perpendicular to the centerline of the hydraulic piping or duct.
- E. Longitudinal Bracing:
 - 1. Restraint(s) applied to limit motion parallel to the centerline of the hydraulic piping or duct.

1.5 PERFORMANCE REQUIREMENTS

- A. Provide vibration isolation on motor driven equipment over 0.5 hp (0.35 kW), plus connected piping and ductwork.

1.6 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the contract and Division 01 Specification Sections.

- B. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- C. Shop drawings for each type of isolator, indicating dimensions, weights, required clearances, and methods of component assembly.
- D. Submit the following in accordance with Conditions of Contract and Division 01 Specifications:
 - 1. Shop drawings of items.
 - 2. Complete description of products to be supplied including product data, dimensions materials of construction and specifications.
 - 3. Installation instructions for each product.
 - 4. Tabulation showing for each vibration isolator supporting equipment:
 - a. Equipment identification tag no.
 - b. Isolator type.
 - c. Actual load.
 - d. Static deflection expected under actual load.
 - e. Specified minimum static deflection.
 - f. Additional deflection to solid under actual load.
 - g. Ratio of spring height under actual load to spring diameter.
 - 5. Layout of piping to be isolated including vertical risers showing:
 - a. Support points.
 - b. Weight at support points.
 - c. Isolator type.
 - d. Static deflection expected under actual load.
 - e. Specified static deflection.
 - f. Additional deflection to solid under actual load.
 - g. Ratio of spring height under load to spring diameter.
 - 6. Special details at large scale and other necessary information to convey understanding of work.
- E. Submission of samples may be requested for each type of vibration isolation device. After approval, samples shall be returned for installation at job site.

1.7 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code - Steel," 2001.
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. Manufacturer of vibration isolation equipment shall have the following responsibilities:
 - 1. Determine vibration isolation sizes and locations.
 - 2. Provide calculations and materials if required for restraint of un-insulated equipment.
 - 3. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
- D. Licensed Operators: Use operators that are licensed by powder-operated tool

manufacturers to operate their tools and fasteners.

- E. Coordinate size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- F. Provide vibration isolators of appropriate sizes and proper loading to meet specified deflection requirements.
- G. Supply and install incidental materials needed to meet requirements, even if not expressly specified or shown on drawings without claim for additional payment.
- H. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- I. Should any rotating equipment cause excessive noise or vibration, rebalance, realign or do other remedial work to reduce noise and vibration levels. Excessive is defined as exceeding manufacturer's specifications for unit in question.
- J. Speed And Balance Requirements For Rotating Equipment:
 - 1. Fans and other rotating mechanical equipment shall not operate at speeds in excess of 80% of their critical speed.
 - 2. Vertical vibration of rotating equipment shall not be greater than levels indicated elsewhere. Measure vibration on equipment or steel frame equipment base when equipment is mounted on its vibration isolation mounts. If equipment has inertia base, allowable vibration level is reduced by ratio of equipment weight alone to equipment weight plus inertia base weight.

| Equipment Speed (rpm) | Vibration Displacement (mils, peak-to-peak) |
|--------------------------|--|
| Under 600 | 4 |
| 600 to 1000 | 3 |
| 1000 to 2000 | 2 |
| over 2000 | 1 |

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, "Carbon Structural Steel," 2001, steel plates, shapes, and bars, black and galvanized.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, "Track Bolts and Nuts," 2000, steel, hex-head, track bolts and nuts.

- C. Washers: ASTM F 844, "Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use," steel, plain, flat washers.
- D. Grout: ASTM C 1107, Grade B, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non shrink)," non shrink, nonmetallic.
 - 1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is non staining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5MPa), 28-day compressive strength.
 - 3. Water: Potable.
 - 4. Packaging: Premixed and factory-packaged.

2.2 VIBRATION ISOLATION MOUNT TYPES

A. General

- 1. Metal parts of vibration isolation units installed out-of-doors shall be hot-dip galvanized, cadmium-plated or Neoprene-coated after fabrication. Galvanizing shall meet ASTM 144 "Salt Spray Test Standards and Federal Test Standard."
- 2. Isolator types are scheduled to establish minimum standards. Optionally, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories shall not degrade vibration isolation system.

B. Unit FSN (Floor Spring and Neoprene) (Type 3)

- 1. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6mm) neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be Model FDS as manufactured by Kinetics Noise Control or type SLF as manufactured by Mason Industries, Inc., or comparable acceptable product.

C. Unit HSN (Hanger Spring and Neoprene) (Type 3)

- 1. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene or pre-compressed elastomer coated fiberglass elements at the top and a steel spring with general characteristics as in specification 5 seated in an optional steel washer reinforced neoprene cup on the bottom. The neoprene element and the optional cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree E arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30 degree E capability. Hangers shall be Model SRH or SFH as manufactured by Kinetics Noise Control or type 30N as manufactured by Mason Industries, Inc., or comparable acceptable product.

2.3 RESILIENT PENETRATION SLEEVE/SEAL

A. Unit RPS-A (Resilient Penetration Sleeve/Seal)

1. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc.

2.4 FLEXIBLE DUCT CONNECTIONS

- A. Flexible duct connections shall be fabricated from Neoprene, loaded vinyl or canvas. Clear space between connected parts shall be a minimum of three inches and connection shall have 1.5" minimum of slack material.

2.5 FLEXIBLE ELECTRICAL CONNECTION

A. Unit FEC-A (Flexible Electrical Connection Type A):

1. Flexible electrical coupling shall be prefabricated units incorporating flexible watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wire way and end hubs with standard tapered electrical threads to fit standard threaded, rigid metal conduit.
2. Unit FEC-A shall be as specified in section "Raceways and Boxes for Electrical Systems" for liquid tight flexible metal conduit.

B. Unit FEC-B (Flexible Electrical Connection Type B):

1. Flexible electrical couplings shall be field-fabricated using minimum 2 ft length of flexible conduit or cable installed in grossly slack "U" shape.
2. Unit FEC-B shall be as specified in section "Raceways and Boxes for Electrical Systems" for flexible metal conduit.

2.6 RESTRAINTS

A. Thrust Restraint

1. Thrust restraints shall consist of spring element in series with Neoprene pad.
2. Thrust restraint shall be designed to have same deflection as specified for isolators supporting equipment generating thrust.
3. Spring element shall be contained within steel frame and be designed to be factory-preset for thrust and be field-adjustable to allow for maximum of 1/4" movement during starting or stopping of equipment.
4. Furnish assembly complete with rods and angle brackets for attachment to both equipment generating thrust and adjacent fixed structural anchor.
5. Thrust restraint shall be Model HSR as manufactured by Kinetics Noise Control or Mason Industries Type WB, or comparable acceptable product.

2.7 GROMMETS

- A. Grommets shall be either custom made by combining Neoprene washer and sleeve, or

be Isogrommets as manufactured by MBIS, Inc., or be Series W by Barry Controls.

- B. Neoprene shall be between 40 and 50 durometer.
- C. Grommets shall be specially formed to prevent fastening bolts from directly contacting isolator base plate.

2.8 ACOUSTICAL SEALANT

A. Sealants for acoustical purposes shall be one of following non-setting sealants:

- 1. Acoustical sealant D.A.P.
- 2. BR-96 Pecra
- 3. Acoustical sealant Tremco
- 4. Acoustical sealant U.S.G.

2.9 VIBRATION ISOLATION SCHEDULE

| | | | Slab on Grade | | | Up to 30 Ft. Floor Span | | | Greater Than 30' Floor Span | | |
|--------------------------------------|-------------------|------|---------------|---------------|-------------------------|-------------------------|---------------|-------------------------|-----------------------------|---------------|-------------------------|
| Fans (Not Within Equipment) | Horsepower/ Other | RP M | Base Type | Isolator Type | Minimum Deflection, IN. | Base Type | Isolator Type | Minimum Deflection, IN. | Base Type | Isolator Type | Minimum Deflection, IN. |
| Inline Centrifugal, Cabinet, Ceiling | All | All | A | 3 | 0.75 | A | 3 | 1.50 | A | 3 | 1.50 |

| | | | Slab on Grade | | | Up to 30 Ft. Floor Span | | | Greater Than 30' Floor Span | | |
|---|-------------------|------|---------------|---------------|-------------------------|-------------------------|---------------|-------------------------|-----------------------------|---------------|-------------------------|
| Miscellaneous Equipment | Horsepower/ Other | RP M | Base Type | Isolator Type | Minimum Deflection, IN. | Base Type | Isolator Type | Minimum Deflection, IN. | Base Type | Isolator Type | Minimum Deflection, IN. |
| Water-Source Heat Pump Units, Outdoor Air Source Heat Pump Units, Indoor Air Handling Units, 100% Outdoor Air Units, and other Miscellaneous Motor Driven Equipment | All | All | A | 3 | 0.75 | A | 3 | 0.75 | A | 3 | 1.50 |

PART 3 - EXECUTION

3.1 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General

1. Locations of vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with manufacturer's written instructions.

B. Isolation Mounts

1. Squarely align vibration isolators above or below mounting points of supported equipment.
2. Isolators for equipment with bases shall be located on sides of bases, which are parallel to equipment shaft unless this is not possible because of physical constraints.
3. If housekeeping pad is provided, isolators shall bear on housekeeping pad and isolator base plate shall rest entirely on pad. Maintain at least ten bolt diameters from isolator anchors to edge of pad.
4. Hanger rods for vibration isolated support shall be connected to structural beams or joists; not from floor slab between beams and joists. Provide intermediate support members as necessary.
5. Position vibration isolation hanger elements as high as possible in hanger rod assembly but not in contact with building structure, and so that hanger housing may rotate full 360 degrees about rod axis without contacting any object.
6. Parallel-running pipes may be hung together on trapeze, which is isolated from building. Isolator deflections must be largest determined by provisions for pipe isolation. Do not mix isolated and non-isolated pipes on same trapeze.
7. No pipes or equipment shall be supported from other pipes or equipment.
8. Resiliently-isolated pipes shall not contact rigid building structure or equipment.
9. Installed and operating heights of vibration-isolated equipment mounted on Unit FSN isolators shall be identical. Limit stops shall be out of contact during normal operation.
10. Adjust leveling bolts and hanger rod bolts so isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases

1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by equipment manufacturer. This provision shall apply whether or not base frame is specified or indicated on drawings. If base frame is required for unit because of equipment manufacturer's requirements and is not specifically called for, base frame recommended by equipment manufacturer shall be provided at no additional expense.
2. Unless otherwise indicated, provide minimum operating clearance of 1.5" between inertia bases or structural steel frames and concrete housekeeping pad on floor beneath equipment. Position isolator mounting brackets so that required clearance is maintained. Check clearance space to ensure that no construction debris has been left to short-circuit or restrict proper operation of vibration isolation system.

D. Flexible Duct Connections

1. Sheet metal ducts or plenum openings shall be squarely aligned with fan discharge, fan intake or adjacent duct section prior to installation of flexible connection, so that clear length is approximately equal all way around perimeter. Flexible duct connections shall not be installed until this provision is met.
2. Fan or adjacent duct section shall be able to move 1" in any direction without causing metal to metal contact or stretching flexible connection taut.

E. Thrust Restraints

1. Attach thrust restraints at centerline of thrust and symmetrically on each side of equipment generating thrust for fans with a static pressure of 2" water column or more.
2. Adjust restraints to limit equipment movement to specified limit.

F. Resilient Penetration Sleeve/Seals

1. Penetration seals shall maintain airtight seal around penetrating element and shall prevent contact of penetrating element and building structure. Fit sleeve tightly to building construction and with acoustical sealant seal airtight on both sides of construction penetrated.

3.2 APPLICATIONS FOR VIBRATION CONTROLS

A. Major Equipment

1. Unless otherwise shown or specified, major floor-mounted equipment shall be set on housekeeping type concrete pads. See architectural or structural drawings for details.
2. Flexible duct connections shall be installed at fan unit intakes, fan unit discharges, and wherever else shown on drawings.
3. Electrical connections to vibration-isolated equipment exposed to weather shall be unit FEC-A.
4. Electrical connections to vibration-isolated equipment located indoors shall be unit FEC-B.
5. Thrust Restraints shall be installed on equipment as called for in schedule on drawings or specified hereunder.

B. Miscellaneous Mechanical Equipment

1. Miscellaneous pieces of mechanical equipment such as domestic water heaters, expansion tanks, etc. shall be vibration-isolated from building structure by Unit FN isolators unless their position in piping system requires higher degrees of isolation as called for under pipe isolation requirements.

C. Pipes

1. Closed loop supply and return piping and refrigerant piping within mechanical rooms or within 50 ft total pipe length (whichever is longer) of connected vibration-isolated equipment (water-source heat pumps, air source heat pumps, etc.), and all of above piping that is 6" or larger, shall be isolated from building structure by vibration mounts, resilient pipe guides, and resilient penetration sleeve/seals.
2. Isolators for first three support points adjacent to connected equipment shall achieve half of specified static deflection of isolators supporting connected equipment. When required static deflection of these pipe isolators is greater than

0.50," Unit FSN or HSN isolators, (whichever is applicable for mounting condition) shall be used.

3. Where lateral support of pipe risers is required within specified limits, use resilient lateral supports.
4. Pipes within specified limits that penetrate building construction shall be isolated from building structure by (Unit RPS-A or Unit RPS-B) resilient penetrating sleeve/seals.

3.3 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Adjust for pipe alignment and final equipment connections. Flexible connections shall not be used for adjustment of alignment.

END OF SECTION

SECTION 23 0553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section, and all sections of Division 23.

1.2 SUMMARY:

A. Section Includes:

1. Painted Identification Materials.
2. Plastic Pipe Markers.
3. Valve Tags.
4. Valve Schedule Frames.
5. Engraved Plastic-Laminate Signs.
6. Plastic Equipment Markers.
7. Plasticized Tags.
8. Duct Markers.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 22 05 00 - "Common Work Results for HVAC."
2. Section 22 05 03 - "Pipes and Tubes for HVAC Piping and Equipment."
3. Section 23 23 00 - "Refrigerant Piping."
4. Section 23 30 00 - "HVAC Air Distribution."
5. Section 23 34 00 - "HVAC Fans."

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems, 2007.

B. National Fire Protection Association:

1. NFPA 99 - Standard for Health Care Facilities, 2005.

1.4 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.
- B. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- C. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

- D. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8 1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. Furnish copies for Maintenance Manuals as specified in the Division 01 Specifications.
- E. Maintenance Data: Include product data and schedules in maintenance manuals, in accordance with requirements of Division 01.

1.5 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1, for lettering size, length of color field, colors, and viewing angles of identification devices.
- C. Equipment Lettering and Graphics:
 - 1. General: Coordinate names, abbreviations and other designations used in HVAC identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of HVAC systems and equipment.
 - a. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification, which indicates individual system number as well as service (for example; Unit Heater No. 3).

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering identification materials which may be incorporated in the work include, but are not limited to, the following:
- B. Manufacturer: Subject to compliance with requirements, provide HVAC identification materials of one of the following:
 - 1. Brady (W.H.) Co.; Signmark Div.
 - 2. Industrial Safety Supply Co., Inc.
 - 3. Seton Name Plate Corp.

2.2 MATERIALS:

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.
- B. Painted Identification Materials:

1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes not less than 1 1/4" high for ductwork and not less than 3/4" high for access door signs and similar operational instructions.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
3. Identification Paint and Background Color; Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems and HVAC equipment comply with ANSI A13.1 for colors. For ductwork, use green paint.

C. Plastic Pipe Markers:

1. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, UV-resistant color-coded pipe markers, complying with ANSI/ASME A13.1
2. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - b. Adhesive lap joint in pipe marker overlap.
 - c. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1 1/2".
3. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - a. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 - b. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
4. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length. Operating pressure of steam systems shall be indicated.
 - a. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
5. Provide pipe markers with the following background colors and designations:

| SERVICE | STENCIL DESIGNATION | LETTER COLOR | BACKGROUND COLOR |
|----------------------|--------------------------|--------------|------------------|
| Refrigerated Suction | Refrigerant Suction (RS) | White | Safety Green |
| Refrigerated Liquid | Refrigerant Liquid (RL) | White | Safety Green |

D. Valve Tags:

1. Plastic Laminate Valve Tags: Provide manufacturer's standard 3/32" thick engraved plastic laminate valve tags, with piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
 - a. Provide 1 1/2" sq. black tags with white lettering, except as otherwise indicated.
 - b. Provide size, shape and color combination as specified or scheduled for each piping system.
2. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16" high letters and sequenced valve numbers approximately 3/8" high, and with

- 5/32" hole for fastener.
- a. Provide 1 1/8" sq. white tags with black lettering.
 - b. Provide size, shape and color combination as specified or scheduled for each piping system.
3. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
 4. Ceiling Grid and Access Panel Markers: Provide Kroy type clear adhesive printed labels with 3/16" high letters to identify the type of concealed HVAC devices.
- E. Engraved Plastic-laminate Signs:
1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 2. Thickness: 1/8", except as otherwise indicated.
 3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
 4. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
 5. Size: Provide approximate 2 1/2" x 4" markers for control devices, dampers, and valves; and 4 1/2" x 6" for equipment.
- F. Plasticized Tags:
1. General: Manufacturer's standard pre-printed or partially pre- printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3 1/4" x 5 5/8", with brass grommets and wire fasteners, and with appropriate pre- printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).
- G. Duct Markers:
1. Identify air: supply, return, exhaust, intake and relief ducts with duct markers or provide stenciled signs and arrows showing service and direction of air flow.
 - a. Locate signs near points where ducts enter into concealed spaces and at maximum intervals of 25 feet.
 - b. Provide identification labels at access panels to locate concealed duct accessories.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION:

- A. General:
1. Coordination: Where identification is to be applied to surfaces, which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
 2. Confined Spaces: Provide labels and signs on all duct and equipment doors, plenums, etc. to indicate service and provide operator warnings as required by OSHA, NFPA, and authority having jurisdiction.
- B. Piping System Identification:
1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - a. Plastic pipe markers, with application system as indicated under "Materials" in this section.
 2. Locate pipe markers and color bands as follows on all piping in occupied spaces, above ceilings, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - a. Near each valve and control device.
 - b. Near each branch, excluding short take-offs for equipment and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ ceilings, or enter non-accessible enclosures.
 - d. At access doors, manholes and similar access points, which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced intermediately at maximum spacing of 25' along each piping run, except reduce spacing to 10' in congested areas.
- C. Valve Identification:
1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, and shut-off valves at HVAC equipment. List each tagged valve in valve schedule for each piping system.
- D. Equipment Identification:
1. General: Install engraved plastic laminate sign on or near each major item of HVAC equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - a. Main control and operating valves, including safety devices and hazardous units.
 - b. Flow meters.
 - c. Water-Source Heat Pump Units.
 - d. Indoor Split System Air Handling Units.
 - e. Outdoor Split System Air Source Heat Pump Units.
 2. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of

size of the principal lettering.

3. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety precautions, and warn of hazards and improper operations.

3.3 ADJUSTING:

- A. Adjusting: Relocate any identification device, which has become visually blocked by work of this division or other divisions.

3.4 CLEANING:

- A. Cleaning: Clean face of identification devices.

3.5 EXTRA STOCK:

- A. Furnish minimum of 5% extra stock of each identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
 1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION

SECTION 23 0593

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including the General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other Sections of Division 23.

1.2 SUMMARY

- A. Coordinate work of this section with all trades.
- B. Work covered in this Section shall be performed after completion of work specified in all Divisions as they related to this work.
- C. Review of design drawings and specifications, and comment on potential problem areas.
- D. Site inspections of ongoing sheet metal installation with written report from each visit.
- E. Air leak testing of ductwork system. See Section 23 05 95 - "Leak Testing, Air Distribution and Duct Systems."
- F. Measurement and setting of all air, and hydronic (closed loop supply and return) water provided or specified in accordance with these contract documents, recording data, making tests, and preparing reports, all as hereinafter specified.
- G. Coordinate with all trades to provide all incidental items not indicated on drawings or in specifications that belong to work described or are required for complete systems balancing, at no additional cost to Owner.
- H. Refer to paragraph "Closeout Submittals" in Section 23 05 00 - "Common Work Results for HVAC."

1.3 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.
- B. Agency Data:
 - 1. Submit proof that proposed testing, adjusting, and balancing agency meets the qualifications specified within 30 days of award of contract.
- C. Engineer and Technicians Data:
 - 1. Submit proof that Test and Balance Engineer assigned to supervise procedures, and technicians proposed to perform procedures meet qualifications specified within 30 days of award of contract.
- D. Procedures and Agenda: Submit synopsis of testing, adjusting, and balancing procedures and agenda proposed to be used for this project within 90 days of award of contract.

- E. Document Review:
1. Submit certification in writing that all design drawings and specifications have been reviewed, and comment on potential problems within 90 days of award of contract.
- F. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems. Include this information in maintenance data specified in Division 01 and Section 23 05 00 - "Common Work Results for HVAC."
- G. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of Test and Balance Engineer. Reports shall be certified proof that systems have been tested, adjusted, and balanced in accordance with referenced standards; are an accurate representation of how systems have been installed; are true representation of how systems are operating at completion of testing, adjusting, and balancing procedures; and are accurate record of final quantities measured, to establish normal operating values of the systems. Follow procedures and format specified below:
1. Report Format: Report forms shall be those standard forms prepared by referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with project identification and a title descriptive of contents. Divide contents of binder into divisions listed below, separated by divider tabs:
 - a. General Information and Summary
 - b. Air Systems
 - c. Hydronic (Closed Loop Supply and Return) Systems
 - d. Automatic Temperature Controls
 - e. Special Systems
 - f. Sound and Vibration Systems
 2. Report Contents: Provide following minimum information, forms and data:
 - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Include certification sheet containing seal and name address, telephone number, and signature of Certified Test and Balance Engineer. Include in this division listing of the instrumentations used for the procedures along with proof of calibration.
 - b. Remainder of the report shall contain appropriate forms containing as minimum, information indicated on standard report forms prepared by AABC and NEBB, for each respective item and system. Prepare schematic diagram for each item of equipment and system to accompany each respective report form.
 3. Reports shall be submitted no later than 30 days after substantial completion.
- H. Final submittal shall include but not be limited to following:
1. List of equipment used to perform test and procedures.
 2. Equipment performance data and equipment curves with actual points of performance indicated on curves as compiled during balancing.
 3. Air Devices including VAV Boxes (supply, return and exhaust) and all air outlets.
 4. Duct traverse readings during balancing.
 5. Room sound power levels where requested by Owner or Architect.
 6. Hydronic system components flow rates, pressures and temperatures.
 7. On balance report documents record date and time of reading.

1.4 QUALITY ASSURANCE

A. Agency Qualifications:

1. General Contractor shall employ the services of independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance the building heating, ventilating and air conditioning systems to produce design objectives. Services shall include checking installations for conformity to design, measurement and establishment of fluid quantities of mechanical systems as required to meet design specifications, and recording and reporting results.
2. Certified by National Environmental Balancing Bureau (NEBB) or by Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in State in which services are to be performed, certified by NEBB or AABC as Test and Balance Engineer.

B. Work shall be accomplished in accordance with specifications. Procedures specified shall be followed and, if not specifically described herein, in general, shall be in accordance with Associated Air Balance Council's National Standards or National Environmental Balancing Bureau's Procedural Standards.

C. Design Review

1. Review all design drawings and specifications. Review shall include:
 - a. Duct pressure classification
 - b. Control device location and balancing devices location in duct systems and piping systems.
 - c. Indicate additional balancing devices required for proper balancing.
 - d. Specifications on all devices required for balancing.
 - e. Note any potential noise problems.
2. Within 90 days of award of contract, meet with the Architect, Mechanical Contractor, and Building Automation System Contractor to review procedures and agenda and comments on design documents as to potential problem areas.

D. Shop Drawing Review

1. Review "Instrumentation and Control for HVAC" shop drawing submittals noting any potential balancing problems. Note comments on submittal, sign, stamp and return to General Contractor. All "Instrumentation and Control for HVAC" submittals must be reviewed by balancing agency prior to review by Architect.

E. Pre-Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct conference with Architect and representatives of installers of mechanical systems. Objective of conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

F. During construction, balancing agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of heating, ventilating, and air conditioning systems. Inspections shall be performed periodically as work progresses. Minimum of two inspections are required as follows: (1) when 60 percent of ductwork is installed; (2) when 90 percent of equipment is installed. Balancing agency shall submit brief written report of each inspection to Owner and Architect.

G. Standards:

1. Associated Air Balance Council (AABC) Publication:
 - a. National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems, Latest Edition.
2. American Society of Heating, Refrigeration and air Conditioning Engineers (ASHRAE) Publications:
 - a. "ASHRAE Research Report No. 1162, "Air Flow Measurements at Intake and Discharge Openings and Grilles," ASHVE Transactions, Volume 46.
 - b. ASHRAE Handbook of Fundamentals, Latest Edition.
3. American National Standards Institute (ANSI) Publications:
4. National Environmental Balancing Bureau (NEBB)
 - a. Procedural Standards for Testing-Balancing- Adjusting of Environmental Systems, Latest Edition.
5. Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA) - Air Duct Leakage Test Manual, Latest Edition.

1.5 OWNER'S INSTRUCTIONS

- A. Balancing contractor's technician along with his balancing engineer shall provide 16 hours of instruction to Owner's engineers on balancing methods, procedures and equipment. Record instruction sessions. Provide the owner three copies of the recordings in digital versatile disk (DVD) format.

PART 2 - PRODUCTS (NOT USED)

Part 3 - EXECUTION

3.1 SYSTEM BALANCE - GENERAL REQUIREMENTS

- A. Balance heating, ventilating, and air conditioning to obtain air and water quantities indicated and required for proper operation of system.
- B. Field work performed under this Section shall be provided under direct supervision of a Registered Professional Engineer.
- C. Furnish services for complete adjustment of water systems and air handling and exhaust systems, water, and air distribution and controls.
- D. During all tests, it shall be demonstrated that systems shall be free from leaks and all parts of system will operate correctly. If not, report deficiencies to Contractor and Owner. Balancing Firm shall make final adjustments to equipment as may be required for proper operation, maintaining correct temperatures in all parts of the building. Controls shall be adjusted by "Instrumentation and Control for HVAC" technicians in conjunction with Balancing Firm. Coordinate setpoints and adjustments with "Instrumentation and Control for HVAC."
- E. Preliminary Work:
1. Inspect project site prior to starting adjustments to verify completion of trades, including general construction, piping system, ductwork system, building automation systems, and electrical systems, as they relate to balancing work. Verification shall include but not be limited to following:
 - a. Ductwork System:
 - 1) Duct joints sealed.
 - 2) Witness leakage tests required under sheet metal section.

- 3) Dampers and control devices installed.
 - b. Piping System (hydronic):
 - 1) Already cleaned and flushed by mechanical contractor.
 - 2) Chemical treatment operating, or applicable to system.
 - 3) System filled and vented of air under Division 15.
 - 4) Proper isolation valves, temporary bypasses and other means and methods provided to allow the building to be balanced without affecting other buildings.
 - c. Proper direction of rotation for motor-driven equipment and for proper speed on multi-speed motors.
 - d. Balancing devices are installed and accessible.
 - e. Control device connections.
 - f. Note problems in general construction of the building that might effect systems performance such as sealing of windows, building joints, exhaust shafts, etc.
 - g. Problems discovered during this inspection shall be reported to General Contractor and Owner.
2. Contractor shall certify in writing that each piping system has been prepared as per this Section, indicating dates procedures were done and which contractor did work. Submit in writing to Architect before beginning balancing work.
- F. Balancing of hydronic systems and parts installed under this Contract to obtain water quantities and temperature drops in all parts of system shown on plans, in specifications, on approved shop drawings or as required by Architect.
- G. Balancing of heating and air conditioning, exhaust and ventilating systems to achieve air quantities specified at each air inlet, outlet, or damper shown on plans at proper conditions of static pressure and temperature differential.
- H. Study and report on excessive noise conditions, which may develop during system balancing. Report shall be sent to Architect.

3.2 AIR SYSTEM BALANCE

- A. In conjunction with "Instrumentation and Control for HVAC", equipment shall be started per design sequence. Determine fan airflow at rated speed. If airflow is not within 10% of design capacity at rated speed, review system conditions, procedures, and recorded data. Check and record pressure drops across filters, compensate for clean versus dirty filters, coils, sound traps, airflow sensors, etc., to indicate excessive pressure loss or leakage. Resolve problems with appropriate contractor. If systems are properly operating, and airflow is still unacceptable, adjust fan drive in accordance with manufacturer's recommendations to obtain proper airflow and static pressure. Systems shall be balanced and operated at lowest feasible static pressure with allowance for filter loading. Record fan suction pressure, fan discharge pressure, amperage and airflow measurement. Correct fan curves to indicated new points of balance. Fan motor shall not be overloaded.
- B. With fan systems adjusted and dampers set to handle normal minimum outdoor air, perform following tests and compile following information:
- 1. Air Handling Equipment
 - a. Design Conditions
 - 1) Supply, Return and Exhaust Airflow
 - 2) Static and Total Pressure
 - 3) Outdoor Airflow
 - 4) Motor rating
 - 5) Fan speed

- 6) Outlet Velocity
- b. Installed Equipment
 - 1) Manufacturer
 - 2) Motor serial number
 - 3) Motor type and efficiency, rating, voltage, phase, full-load amperes.
- c. Field Test
 - 1) Fan speed
 - 2) No-load operating amperes
 - 3) Fan motor operating amperes
 - 4) Calculated motor output
- d. Test for Total Air
 - 1) Sum of discharge, exhaust, return air and outside air ducts.
 - 2) Number and locations of velocity readings taken.
 - 3) Duct average velocity
 - 4) Total airflow
- e. After completion of tests, adjustments, and balancing under minimum outdoor air conditions, set system for 100% outdoor air. Repeat the total airflow tests to check field versus design conditions. Results under 100% outdoor air cycle shall agree with conditions found under "minimum fresh air operation" before system is considered to be in balance. Adjustments of proper dampers shall be made to achieve balance.

C. With supply, return, and exhaust systems properly adjusted for airflow and static pressure, conduct following test, adjustments and compilation of data:

- 1. Duct Mains and Branches:
 - a. Adjust, measure and record airflow, static pressure of duct mains and branch ducts to provide required pressure and airflow at terminal devices.
- 2. Terminal Devices:
 - a. Manufacturer, Model No. and Size of airflow control terminal units (supply, return and exhaust).
 - b. Inlet velocity, static pressure, minimum and maximum airflow setpoints of valves.
 - c. Outlet airflow of valve.
 - d. Adjust minimum or maximum setting of valves as required to obtain required airflow of outlets in accordance with manufacturer's procedures and recommendations.
 - e. In conjunction with "Instrumentation and Control for HVAC", operate controls, i.e., thermostats, switches and pressure controls in accordance with design sequence to verify proper operation.
 - f. Report control problems in writing to the Contractor. Resolve sequence problems with Section "Instrumentation and Control for HVAC", the Contractor and Architect at no additional cost.
- 3. Air Outlets (supply, return and exhaust registers diffusers and grilles)
 - a. Manufacturer, model number, size of outlet and number of throw directions.
 - b. Design and actual airflow.
 - c. Adjust outlets to obtain design airflow within +5%.
 - d. Adjust direction of throw as required to match final installation location to prevent drafts.
 - e. With supply, return and exhaust balanced to design airflow, report room pressurization, (positive or negative). Report pressure readings relative to adjacent spaces only where requested by Owner or Architect.

D. Sheaves And Belts:

1. Should the air balance not meet acceptable industry standard tolerances as referenced herein, change and replace sheaves and belts to provide a final acceptable air balance. Replacement of sheaves and belts shall be provided at no additional cost.

3.3 HYDRONIC SYSTEM BALANCE

A. Only the work installed under this contract shall be balanced. Provide all necessary isolation valves, temporary bypasses and other means and methods to accommodate. Notify the Architect in writing before entering the central plant in Community Building 1 and adjusting the existing pumps or other equipment.

B. In conjunction with the Instrumentation and Controls Technician, all equipment shall be started per design sequence. With manual valves open, and control valves in normal position, adjust discharge balancing valves to obtain design flow.

C. With pump system adjusted, perform following tests, compile data and submit report:

1. Pipe Mains and Branches:

a. Adjust branch balancing valves to obtain pressure and flowrates required for terminal devices, i.e., water-source heat pumps, etc.

b. Provide the following:

- 1) Design and actual flow rate and pressure drop.
- 2) Record entering and leaving water temperatures.

c. Terminal Devices (Water-Source Heat Pumps):

- 1) Manufacturer's model number, type of terminal device and rated heat output.
- 2) Flowrate and differential pressure through component including control device.
- 3) Adjust balancing device to obtain required flowrate through device, in accordance with manufacturer's procedures and recommendations.
- 4) Record temperatures of fluid at inlet and outlet of device. Record temperatures of air entering and leaving coils. Compare data with design performance, if data is not in conformance with approved shop drawings or design intent, readjust water system to obtain acceptable performance.
- 5) With air and water system balanced and in conjunction with "Instrumentation and Control System" operate controls, i.e., thermostats, switches, etc., in accordance with design sequence to verify proper operation.
- 6) Report control problems in writing to General Contractor. Resolve sequence problems with Instrumentation and Controls Technician, the Contractor and Architect at no additional cost.

d. Heat transfer equipment including closed loop systems and water-source heat pumps, etc.

1) Measured Parameters

- a) Flowrate.
- b) Heat transfer.
- c) Entering and leaving temperatures.
- d) Pressure drops.
- e) Ambient dry and wet bulb (for cooling towers).

- 2) Equipment data
 - a) Manufacturer and model number.
 - b) Motor output horsepowers.
 - c) Serial numbers.
- 3) Design Data
 - a) Include design data in submittal for comparison.

D. It is not the intent of this contract to re-balance the existing closed loop pumps in the Central Plant of Community Building 1. Should the pumps need to be re-balanced under this contract, they shall be rebalanced as a part of the contract without request for additional payment.

- 1. Notify the Architect in writing that the contract will require the closed loop pumps in the central plant of Community Building 1 to be rebalanced. Do not commence re-balancing existing equipment in the central plant until approval is given by the Architect.
- 2. Field verify existing pump manufacturer and model number and other relevant information including motor horsepower. Obtain all relevant information from pump manufacturer including pump curves and operations and maintenance manuals.
- 3. Verify existing brake horsepower, flow and pressure. Verify existing balancing valve setting.
- 4. Adjust pump to desired flow and pressure setting via balancing valve and variable frequency drive.
- 5. With pump system adjusted, perform following tests, compile data and submit report:
 - a. Pumps
 - 1) Design Data
 - a) Flow and total dynamic head.
 - b) Pump speed, and motor output.
 - 2) Installed equipment
 - a) Manufacturer, size and model number.
 - b) Type drive.
 - c) Motor rating, voltage, and phase.
 - d) Full-load amperes.
 - 3) Field Test
 - a) Discharge pressures: Full flow and zero flow.
 - b) Suction pressures: Full flow and zero flow.
 - c) Operating flow and total dynamic head
 - d) No-load amperes (where possible.)
 - e) Full-flow amperes, zero-flow amperes.
 - f) Calculated motor output.
 - 4) Compare data with pump submittal curve. If test point falls on curve, proceed with balancing. If recorded data does not fall on pump curve, plot new curve parallel with other curves on chart, from zero to maximum flow. Open discharge balancing valve to full and record discharge pressure, suction pressure and total head. Readjust balancing valve to obtain suction and discharge design flow and pressure, and record data. Check and record pump motor voltage and amperage. Pump motor shall not be overloaded.

3.4 ACOUSTICS AND NOISE CRITERIA

- A. Verify that mechanical systems comply with noise criteria as specified and indicated in Division 23. Where compliance is questionable or where requested by Owner, Architect

or Contractor, take sound power level reading and record. Diagnose equipment causing deviations and report deviations to appropriate trade contractor and Contractor. Resolve noise problems with Contractor and appropriate Installer.

3.5 CALIBRATION

- A. During testing and balancing, inspect temperature sensors, pressure sensors, humidity gauges, digital indicators, and thermometers, provided under Division 23. Report discrepancies to the Contractor for replacement or recalibration.

3.6 RE-BALANCE

- A. After Architect's review of test and balance report submittal, make adjustment in any balancing point as required by Architect, to correct discrepancies between balance report and design, at no additional cost.

PART 1 - GENERAL

- A. Visit site within one year after building occupancy if necessary to adjust and rebalance, any system required by Owner, to resolve any and all complaints. After final balance, revise previous submittal and resubmit to architect for record purpose. Rebalance and resubmittals shall be done at no additional cost to Owner.

END OF SECTION

SECTION 23 0595

LEAK TESTING, AIR DISTRIBUTION AND DUCT 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 and the other Sections of Division 23.

1.2 SUMMARY

- A. Section includes:
 - 1. Leak testing of duct systems.
 - 2. Leak testing of HVAC units.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Section 23 05 48 – “Vibration and Seismic Controls for HVAC Piping and Equipment:” Requirements for flex connectors.
 - 2. Section 23 30 00 - “HVAC Air Distribution:” Ductwork requirements.
 - 3. Section 23 34 00 – “HVAC Fans:” Requirements for HVAC Fans.
 - 4. Section 23 81 43 – “Water-Source Heat Pumps:” Water-source heat pump requirements.
 - 5. Section 23 81 46 – “Air Source Unitary Heat Pumps:” Requirements for split system indoor air handling units.

1.3 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.

1.4 QUALITY ASSURANCE

- A. Testing shall be performed by Installer of system being tested in presence of the Owner’s representative. Provide seven (7) day advance notice prior to testing of systems.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Duct Leak Testing:
 - 1. Test the entire ductwork air distribution system.
 - 2. Disassemble, reassemble, and seal segments of systems to accommodate leak testing and for compliance of test requirements.
 - 3. Prior to installing insulation, conduct tests at static pressures equal to the maximum design pressure for each section of the system. If pressure classifications are not indicated, test entire system at the maximum system design pressure. Do not pressurize systems above the maximum design

- operating pressure.
4. Determine leakage from entire system or from each section of the system being tested by relating leakage to the surface area of the test section.
 5. Maximum Allowable Leakage: As described in SMACNA HVAC Air Duct Leakage Test Manual, latest edition. Comply with requirements for leakage classification 3 for round ducts, leakage classification 12 for rectangular ducts in pressure classifications less than and equal to 2 inches water gage (both positive and negative pressures), and leakages classification 6 for pressure classifications greater than 2 inches water gage and less than and equal to 10 inches water gage.
 6. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
 7. Record leakage testing results on forms from the SMACNA HVAC Air Duct Leakage Test Manual. Submit results within one week of testing.

END OF SECTION

SECTION 23 0700

HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the contract, including General and Supplemental Conditions and Division 01 Specifications, apply to this section and all sections of Division 23.

1.2 SUMMARY

- A. Section includes:

1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Duct lining.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied cloths.
10. Field-applied jackets.
11. Tapes.
12. Securements.
13. Corner angles.

- B. Related Sections: The following sections contain requirements that relate to this section.

1. Section 23 05 03 – “Pipes and Tubes for HVAC Piping and Equipment:” Product requirements for piping.
2. Section 23 05 16 – “Expansion Fittings and Loops for HVAC Piping:” Product requirements for expansion loops and fittings.
3. Section 23 05 23 – “General Duty Valves for HVAC Piping:” Product requirements for valves.
4. Section 23 05 29 – “Hangers and Supports for HVAC Piping and Equipment:” Product and Execution requirements for inserts at hanger locations.
5. Section 23 05 53 – “Identification for HVAC Piping and Equipment”: Product requirements for HVAC piping and equipment identification.
6. Section 23 30 00 – “HVAC Air Distribution:” Product requirements for ductwork.

1.3 REFERENCES

(Unless otherwise noted, references apply to “latest editions.”)

- A. ASTM International:

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
4. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
5. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
6. ASTM C423 – Standard for Reverberation Room Method.
7. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
8. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
9. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
10. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
11. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
12. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
13. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
14. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
15. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
16. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
17. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
18. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
19. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
20. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
21. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
22. ASTM 1622 – 08 Standard Test Method for apparent density, apparent density, apparent overall density.
23. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
24. ASTM D3575 – 08 Standard Test Methods for flexible cellular materials made from Olefin Polymers, closed cell materials, flexible cellular, Olefin Polymers, Buoyancy, etc.
25. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
26. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
27. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
28. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
29. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

- B. Sheet Metal and Air Conditioning Contractors':
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.4 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Samples: Submit two samples of representative size illustrating each insulation type.
- D. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Perform Work in accordance with all applicable codes, standards and local authorities having jurisdiction requirements.
- C. Maintain one copy of each document on site.
- D. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke developed index of 150 or less.
- E. Insulation materials shall be tested and rated according to ASTM Test Method C-177 to determine k-factors. ASTM C 335 is for pre-formed pipe insulation. C177 is for flat slab materials such as board products, etc.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience and service facilities within 50 miles of the project.
- B. Applicator: Company specializing in performing Work of this section with minimum three years experience.
- C. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping. Remove and replace any wet or damaged unsatisfactory insulation at the Architect's direction.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Furnish five year manufacturer warranty for manmade fiber.

1.11 DEFINITIONS

- A. ASJ: Al-service jacket.
- B. FSK: Foil, scrim, Kraft paper.
- C. FSP: Foil, Scrim, polyethylene.
- D. PVDC: Polyvinylidene chloride.
- E. SSL: Self-sealing lap.
- F. ASJ: All service jacket composed of aluminum foil reinforced with glass scrim bonded to a Kraft paper interweaving with an outer film layer leaving no paper exposed.
- G. PSK: Poly Scrim Kraft.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles blow introduce lists, the following requirements apply to product selection.
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

- A. Refer to Part 3 execution schedule for requirements regarding where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, mercury compounds, or formaldehyde.
- C. Insulation products shall contain no formaldehyde-based binders or will be third-party certified for conformance with Greenguard children and schools or Indoor Advantage Gold.
- D. When product to be in contact with austenitic stainless steel is tested according to ASTM C795 (which includes ASTM C692 and ASTM C871), the PH of the leach water from the specific material supplied shall be greater than 7.0 but not greater than 11.7 at 77°F (25°C). An acceptable proportion of sodium plus silicate ions to the chloride ions as found by leaching from the insulation is shown in the “plot point” of figure 6 in ASTM C795.
- E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- F. Foam insulation materials shall not utilize CFC or HCFC blowing agents in the manufacturing process.
- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in Part 2 “Factory-Applied Jackets” Article.
 - 1. Products:
 - a. Pittsburgh Corning Corporation; Foamglass
 - b. Specialty Products & Insulation Company (SPI), Lancaster, PA.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 - 6. Maximum K-Factor: 0.29 at 75 deg. F. mean temperature.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Closed-cell polyolefin/polyethylene insulation is not acceptable as a substitution for ASTM C534 closed-cell rubber materials.
 - 1. Products:
 - a. Aeroflex USA Inc.: Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. Nomaco; K-Flex Pipe
 - 2. Water Vapor Permeability: 0.02 perm-inch per ASTM E96 Procedure A.
 - 3. Warranty: 25 year warranty against breakdown of the membrane due to ultraviolet radiation.
 - 4. Seal Tape: Thermoplastic rubber membrane backed with pressure sensitive adhesive.
 - 6.

- I. 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 III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
1. Products:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite Duct Wrap or Microlite XG.
 - c. Knauf Insulation; Friendly Free Duct Wrap with Ecose® Technology.
 - d. Owens Corning; All-Service Duct Wrap Type 100.
 2. Maximum K-Factor: 0.24 at 75 deg. F. and material thickness compressed 25%.
 3. Minimum Density: 1.5 pounds per cubic foot.
- J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
1. Products:
 - a. Johns Manville; HTB 23 Spin-Glas.
 - b. IIG Industries
 2. Maximum K-Factor: 0.23 at 75 deg. F.
 3. Minimum Density: 2.0 pounds per cubic foot.
- K. 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 with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
1. Products:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas, Type 814.
 - c. Knauf Insulation; Insulation Board with Ecose® Technology, suitable for operating temperatures up to 450°F.
 - d. Knauf Insulation: Elevated Temperature Board with Ecose® Technology for operating temperatures to 1000°F.
 - e. Owens Corning; Fiberglas 700 Series for operating temperatures up to 450°F.
 - f. Owens Corning; Insul-Quick for operating temperatures up to 850°F.
 2. Maximum K-Factor: 0.23 at 75° F.
 3. Minimum density: 3.0 pounds per cubic foot.
- L. High-Temperature Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
1. Products:
 - a. Johns Manville: 1000 Series Spin-Glas.
 - b. Knauf Insulation: Elevated Temperature Board with Ecose® Technology for operating temperatures to 1000°F.
 - c. IIG Industries
 - d. Rock Wool Manufacturing Company; Delta Board.
 2. Maximum K-Factor: 0.23 at 75 deg. F mean temperature; 0.33 at 300 deg. F mean temperature.
 3. Minimum Density: 3.0 Pounds per cubic foot.

2.3 FIRE RATED INSULATION KITCHEN HOOD/EQUIPMENT FLUE EXHAUST SYSTEMS

- A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C656, Type II, Grade 6. UL tested and certified to provide a 2-hour fire rating.
 - 1. Products:
 - a. Johns Manville; Super Firetemp M.
- B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating.
 - 1. Products:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. 3M; Fire Master Wrap Products.

2.4 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.5 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. Cellular-Glass and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 81-84.
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products:
 - a. Armacell LCC; 520 BLV Adhesive.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-60.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 85-70.
 - b. Eagle Bridges - Marathon Industries, Inc.; 225.
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 85-70.

- b. Eagle Bridges - Marathon Industries, Inc.; 225.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
- G. Polyurethane Foam Insulation Board: Manufacturer's recommended synthetic adhesive compatible with polyurethane insulation.
 - 1. Products:
 - a. Sarnafil Sarnacol 2170 or Sarnacol 21425.

2.6 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - b. Eagle Bridges - Marathon Industries, Inc.; 590.
 - c. Mon-Eco Industries, Inc.; 55-40.
 - d. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - b. Eagle Bridges - Marathon Industries, Inc.; 550.
 - c. Mon-Eco Industries, Inc.; 55-50.
 - d. Vimasco Corporation; WC-1/WC-5.
 - 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 200 deg F.
 - 4. Solids Content: 63 percent by volume and 73 percent by weight.
 - 5. Color: White.

2.7 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 81-42W.
 - b. Eagle Bridges - Marathon Industries, Inc.; 130.
 - c. Vimasco Corporation; 713/714.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.8 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass and Polyisocyanurate Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - b. Eagle Bridges - Marathon Industries, Inc.; 405.
 - c. Mon-Eco Industries, Inc.; 44-05.
 - d. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - b. Eagle Bridges - Marathon Industries, Inc.; 405.
 - c. 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.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.9 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. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. ASJ+SSL: ASJ+ - SSL: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.
4. Redi-Klad Jacket: Factory applied Venture Clad 5-ply weather ad abuse resistant with self-sealing lap. Zero permeability per ASTM E 96-05; puncture resistance 35.4 kg (189.3 N) per ASTM D 1000; tear strength 4.3 lb (19.4 N) per ASTM D 624; thickness 14.5 mils (0.0145"); tensile strength 68 lb/inch width [306 N (32 kg)/25 mm].

5. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.
6. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
7. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
8. PVDC Jacket for Indoor Applications: 4-mil thick, white PVDC bioxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
9. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Products:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
10. Vinyl Jacket: UL-rated white vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.
11. ASJ: Owens Corning Evolution™ paper-free ASJ pipe insulation.
12. PSK Jacket, Polypropylene scrim with Kraft.

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.
 1. Products:
 - a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

2.11 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with Kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 20 mil thickness; roll stock Ready for shop or field cutting and forming.
 1. Products:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: white.
 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 and mechanical joints minimum 20 mil thickness.
5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

- 1. Products:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - 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. Thickness:
 - 1) Up to 24 inch diameter, width, or height: 0.016 inch minimum.
 - 2) 25 inch to 59 inch diameter, width, or height: 0.024 inch minimum.
 - 3) 60 inch and larger diameter, width, or height: 0.032 inch minimum.
 - c. Finish: Smooth finish.
 - d. Color: White
 - e. Moisture Retarder: 3-mil- thick Polysurlyn (co-extrusion of polyethylene and Dupont Surlyn® , heat laminated to the metal jacketing).
 - f. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and longradius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

- 1. Products:
 - a. Polyguard; Alumaguard 60.
 - b. MFM Building Products Corp., Flex Clad 400.
 - c. Venture Clad Jacketing.

F. Rubber Membrane: 48-mil thick membrane consisting of a glass fiber carrier coated on both sides with liquid PVC-P Plastisol, and laminated to polyester fleece.

G. Pipe Sound Lagging: Loaded vinyl with fibrous glass scrim reinforced aluminum foil facing over 2-inch thick quilted fiberglass decoupler. Loaded vinyl shall be 2 psf minimum surface weight. Glass fiber pipe wrap shall be semi-rigid, preformed type, 2- inch minimum thickness, 1-1/2 pcf density.

- 1. Manufacturers:
 - a. Kinetics.

- b. Sound Seal.
 - 2. Sound Transmission Class (STC) Rating: 26.
- H. Duct Sound Lagging: Reinforced, loaded vinyl noise barrier.
 - 1. Products:
 - a. Kinetics; KNM-100 AL
 - b. Sound seal; B-10R
 - c. Unger Technologies, Inc.; Model DL-10-LAG
 - 2. Sound Transmission Class (STC) rating: 26.
 - 3. Density: 1 pound per square foot.

2.12 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
 - 1. 1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - 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 in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
 - 1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
 - 2. Width: 3 inches.
 - 3. Thickness: 6.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 - 1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 - 2. Width: 2 inches.
 - 3. Thickness: 6 mils.

4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Products:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.13 SECUREMENTS

A. Bands:

1. Products:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.
 - a. Products:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Products:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products:

- 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates
 - e. indicated without damaging insulation, hangers, and substrates.
 5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
1. Manufacturers:
 - a. ACS Industries, Inc.
 - b. C & F Wire.
 - c. Childers Products.
 - d. PABCO Metals Corporation.
 - e. RPR Products, Inc.

2.14 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

2.15 DUCT LINING

- A. Products:
 - 1. K-Flex Gray Duct Liner with PSA
- B. Material shall have a density ranging from 3 to 6 lb/ft³ (ASTM D1622, ASTM D3575).
- C. Material shall have a maximum thermal conductivity (k) of 0.25 Btu-in/hr-ft²-°F @ 75°F mean temperature (ASTM C518, ASTM C177).
- D. Material shall have a minimum R-value of 6 at a nominal 1 ½" thickness.
- E. Material shall have a maximum Water Vapor Transmission rate of 0.10 Perm-in. (ASTM E96, Desiccant Method).
- F. Material shall have a minimum sound absorption coefficient (NRC) of 0.50 at a nominal 1 ½" thickness (ASTM C423).
- G. Material shall have a flame spread rating not greater than 25 and a smoke developed rating not greater than 50 when tested in accordance with ASTM E84 at a thickness required to attain a minimum 6 R-value.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to the Division 01 specifications for coordination and project conditions.
- B. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

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 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and 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. Install insulation continuously through hangers and around anchor attachments.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at 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.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. 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 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- N. Cut and install insulation in a manner to avoid compressing insulation more than 25 percent of its original nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. 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.
- Q. Replace insulation on existing piping, and equipment where indicated on the drawings. Match insulation type and thickness indicated by the insulation schedule at the end of this section.
- R. Replace insulation on new and existing piping, and equipment where insulation is damaged during construction or removed for testing and balancing work.
- S. 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.
 8. Flanges.
 9. Expansion joints.
- T. Duct and plenum liner application.
1. Adhere insulation with 90% adhesive coverage with mechanical pin fasteners.
 2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
 3. Seal and smooth joints. Seal and coat transverse joints.
 4. Seal liner surface penetrations with adhesive.
 5. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.
- U. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- V. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and

heat trace. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

- W. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.
- X. Exterior and Garage Applications: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal equipment.

3.4 BUILDING 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 Below-Grade 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. 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.
- F. Insulation Installation at Floor Penetrations:
 - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match

2. adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
Pipe: Install insulation continuously through floor penetrations.

3.5 DUCT AND PLENUM INSULATION INSTALLATION

- A. Provide Blanket Insulation Installation on Ducts and Plenums: Secure with SMACNA recommended anti-sag insulation pins for the bottom of ductwork over 24" wide.
 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. Protect exposed corners with secured corner angles.
 4. 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.

3.6 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. Fittings shall be insulated to same thickness as the adjoining insulation. Apply fittings per fitting manufacturer's instructions. When required by specification, a hard insert of sufficient length shall be utilized to avoid compression of the 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 wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric 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.
 9. 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, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation 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. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but 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 cut sections of cellular glass block insulation of same thickness as pipe 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. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with 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, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) 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 (10 deg C) at 18-foot (5.5-m) 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 width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
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 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 overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2- inch (13-mm) outward-clinching staples, 1 inch (25 mm) 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 (10 deg C) at 18-foot (5.5-m) 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 2 times the insulation thickness but not less than 3 inches (75 mm).
 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.

3.10 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
1. Where rubber membrane jackets are indicated, install the membrane using the manufacturer's recommended adhesive. Before use thoroughly stir the adhesive. Replace the container lid when work is interrupted. If required thin the adhesive as recommended by the manufacturer.
 2. Using a sheepskin or similar roller apply a primer coat of adhesive to the roof surface, priming only the area of roof where the membrane will be laid the same day. Allow adhesive to dry.
 3. Unroll the membrane and fold back approximately half its length.
 4. Apply adhesive with a sheepskin or similar roller to the underside of the membrane ensuring the weld area is kept free of adhesive and allow to touch dry.
 5. Carefully roll out the membrane over the previously primed surface and roll with water filled roller.
 6. Fold back other half of the roll of membrane and repeat the procedure.
 7. Unroll the next roll of membrane, ensuring the end laps are staggered and the side overlaps the previously installed sheet by 2 inches.
 8. Repeat the adhering process.
 9. Fully hot air weld the 2-inch side lap, allow to cool completely.
 10. Mechanically check the integrity of the cooled weld by running a 3/16-inch wide screwdriver (with rounded edges) along the seam applying pressure into the seam.
 11. Install Peel Stop and PVC Welding Cord at all perimeters, penetrations and changes of roof direction.
- E. Pipe Sound Lagging:
1. Seal and fasten in accordance with manufacturer's written instructions to maintain specified STC rating.
 2. Cover entire pipe with glass fiber wrap. Fill all voids with clean glass fiber scrap. Apply over this wrap an airtight cover of loaded vinyl. Do not connect the cover rigidly to pipe or hangers. Overlap longitudinal seams in loaded vinyl 2-inch minimum and tape with cloth-backed tape. Overlap edge seams 1-inch minimum

and tape with cloth-backed tape or with acoustical sealant. Extend ends of cover within 1/2-inch of penetration through wall, ceiling, and/or floor. Seal annular gap between pipe lagging and penetration airtight with acoustic sealant.

3. Duct lagging shall be independently supported gypsum board with batt insulation.

3.11 FINISHES

- A. Finish Duct, Equipment, and Pipe Insulation with ASJ, Glass Cloth, or Other Paintable Jacket Material. Clad-Type Jacketing such as Venture RediKlad or Venture Clad may be utilized.
- 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.

3.12 INSULATION APPLICATION SCHEDULE

- A. Acceptable insulation materials, thickness and vapor retarder requirements are identified for each application and size range. If more than one material is listed for an application and size range, selection from the materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Fire-suppression piping.
 2. Below-grade piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
 4. General exhaust ductwork (Not including kitchen exhaust ductwork and elevator relief ductwork which is required to be insulated).
 5. Factory-insulated flexible ducts.
 6. Factory-insulated plenums and casings.
 7. Flexible connectors.
 8. Vibration-control devices.
 9. Factory-insulated access panels and doors.
- C. All supply and outside air ductwork with internal sound lining shall be externally insulated.
- D. Where metal ducts are specified to have internal duct liner, the thickness of the external insulation may be reduced by one inch, except minimum duct external insulation thickness shall be 1 inch.

3.13 HVAC PIPING INSULATION APPLICATION SCHEDULE:

| HVAC SERVICE | TYPES OF INSULATION MATERIAL | INSULATION THICKNESS REQUIRED | VAPOR RETARDER REQUIRED |
|---|------------------------------|-------------------------------|-------------------------|
| INDOOR REFRIGERANT SUCTION, HOT GAS PIPING AND ALL REFRIGERANT PIPING CONNECTED TO THE VRF SYSTEM (Refer to Note 1) | | | |
| All sizes, Generally | Flexible Elastomeric | 1/2" | Yes |

| | | | |
|--|----------------------|--------|-----|
| All sizes, Unconditioned Space (Refer to Note 1) | Flexible Elastomeric | 1-1/2" | Yes |
| OUTDOOR REFRIGERANT SUCTION, HOT GAS PIPING AND ALL REFRIGERANT PIPING CONNECTED TO THE VRF SYSTEM | | | |
| All sizes | Flexible Elastomeric | 1" | Yes |

3.14 HVAC DUCTWORK INSULATION APPLICATION SCHEDULE

| HVAC SERVICE | TYPES OF INSULATION MATERIAL | INSULATION THICKNESS REQUIRED | VAPOR RETARDER REQUIRED |
|---|------------------------------|-------------------------------|-------------------------|
| SUPPLY-AIR DUCTS AND PLENUMS | | | |
| Indoor Service: (Refer to Note 1) | | | |
| Concealed | Mineral-Fiber Blanket | 1-1/2" | Yes |
| Exposed | Mineral-Fiber Board | 1-1/2" | Yes |
| Attic Spaces and Unconditioned Spaces – Excluding Ducts in the Garage (Refer to Note 1) | Mineral-Fiber Board | 2" | Yes |
| | | | |
| GARAGE ABOVEGROUND SUPPLY-AIR DUCTS AND PLENUMS (REFER TO NOTE 3) | | | |
| For All Locations and Supply Air Temperatures | Mineral-Fiber Board | 2" | Yes |
| INDOOR RETURN-AIR DUCTS, RELIEF-AIR DUCTS, AND PLENUMS | | | |
| In locations other than attics and unconditioned spaces | None | -- | -- |
| Attic Spaces and Unconditioned Spaces – Excluding Elevator Relief Ducts (Refer to Note 1) | Mineral-Fiber Board | 1" | Yes |

| | | | |
|--|---|--|-------------------------------|
| Between Relief-Air Damper and Outdoors (Louver, louvered penthouse, etc.) | Mineral-Fiber Board | 2" | Yes |
| Between Elevator and Relief Damper | Fire Rated Blanket or Fire Rated Board | As Required for Specified Fire Rating | No |
| HVAC SERVICE | TYPES OF INSULATION MATERIAL | INSULATION THICKNESS REQUIRED | VAPOR RETARDER REQUIRED |
| OUTSIDE-AIR DUCTS AND PLENUMS | | | |
| Indoor Service: | | | |
| Concealed | Mineral-Fiber Blanket | 1-1/2" | Yes |
| Exposed | Mineral-Fiber Board | 2" | Yes |
| Attic Spaces | Mineral-Fiber Board | 2" | Yes |

Schedule Notes:

1. Unconditioned spaces include locations where summer temperature and humidity conditions are similar to outdoor conditions (such as mechanical rooms ventilated with unconditioned outdoor air, parking garages, pedestrian tunnels, etc.)
2. Where rigid pipe insulation (cellular glass, etc.) is scheduled, provide mineral fiber through and 6 inches beyond pipe sleeves, to allow for pipe expansion.
3. Top of ductwork located outdoors shall be provided with cellular glass, or polyurethane board insulation. Taper insulation to shed water, minimum 1/4" per foot slope, with insulation thickness at low edges equal to scheduled insulation thickness.
4. All diffuser cones, air valves, damper boxes, HVAC equipment, coils, coil headers, casings, plenums, air measuring devices, chilled beams, etc. shall be insulated.

3.15 FIELD APPLIED JACKET APPLICATION SCHEDULE

| SERVICE | FIELD APPLIED JACKET TYPE |
|--|------------------------------|
| Indoor, exposed insulated piping within 12 feet of floor, for service temperatures 200 degrees F and below | PVC |
| Indoor, exposed insulated piping within 12 feet of floor, for service temperatures 200 degrees F and below | Aluminum |

| | |
|--|--------------------------------------|
| Indoor, exposed insulated piping greater than 12 feet above floor, generally | None |
| Indoor concealed piping | None |
| Outdoor exposed piping | Aluminum |
| Indoor, All Locations, Fittings and valves in piping systems at service temperatures 200 degrees F and below | Factory Fabricated PVC covers |
| Indoor, All Locations, Fittings and valves in piping systems at service temperatures 200 degrees F and below | Aluminum |
| SERVICE | FIELD APPLIED JACKET TYPE |
| Indoor, exposed insulated ductwork within 12 feet of floor | Woven Glass Fiber Fabric |
| Indoor, exposed insulated ductwork greater than 12 feet of floor | None |
| Indoor, concealed insulated ductwork | None |
| Indoor, exposed insulated ductwork | Aluminum |
| Garage exposed insulated ductwork, Alternative jacket material | Aluminum |
| Ductwork in high noise areas (as indicated on the drawings) | Duct Sound Lagging (Refer to Note 3) |
| All insulated piping within custom AHU service corridors for service temperatures 200 degrees F and below | PVC |
| All insulated piping within custom AHU service corridors for service temperatures 200 degrees F and below | Aluminum |
| Piping in sound sensitive areas (as indicated on the drawings) | Pipe Sound Lagging (Refer to Note 3) |
| Equipment, generally (Refer to Notes 1 & 2) | Woven Glass Fiber Fabric |
| Equipment, Cold surface (Refer to Notes 1 & 2) | PVC |

Jacket Application Schedule Notes:

1. Refer to Part 3 specification section titled "Mechanical Equipment, Tank, and Vessel Insulation Installation" for requirements for revocable, re-usable metal boxes lined with insulation at pumps.
2. Including factory insulated equipment without factory applied jacket.
3. If ductwork or piping indicated to have sound lagging also requires an additional field jacket, install sound lagging between insulation and additional field jacket.

END OF SECTION

SECTION 23 0800
VERIFICATION FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. General requirements that apply to implementation of Verification of HVAC systems, assemblies and components.

C. Related Sections:

1. Division 01 Section "General Requirements."
2. Division 01 Section "Special Procedures."
3. Division 23 HVAC Sections.

1.2 REFERENCES

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.
4. Refer to Division 23 Section "Common Results for HVAC" for codes and standards, and other general requirements.

1.3 DESCRIPTION

- A. The purpose of verification is to ensure the Owner that work has been completed as specified and that systems are functioning in the manner as described in Division 23 Section "Common Results for HVAC" and specified system operating criteria. It will assist operating staff training and familiarization with new systems. It will serve as a tool to reduce post-occupancy critical systems operational difficulty or failure. It will, also, be used to develop test protocol and record the associated test data in an effort to advance the building systems from a state of substantial completion to a full dynamic operation.
- B. Verification will commence after preliminary punch list items are completed by Contractors.
- C. The steps associated with Verification are outlined below:
1. Step One - Installation Verification

2. Step Two - System Start-Up.
 3. Step Three – Performance Testing.
- D. Operational staff training is essential to the verification process and will run concurrently with steps one through three.
- E. The Verification Team will include representatives of the Owner, Construction and Installing Subcontractors, Test and Balance Subcontractor, and FMCS Subcontractor. Equipment manufacturer’s representatives will be present for start-up as specified in the equipment specification sections and for equipment training.
- 1.4 SYSTEMS TO BE VERIFIED
- A. Verification will be performed on the following systems:
1. Facility Monitoring and Control System (FMCS)
 2. Supply and Return Air Systems.
 3. Air Terminals.
 4. VRF Systems
 5. Unitary Equipment.
 6. Fans
 7. Ductwork
 8. Ductwork accessories including Fire Dampers

1.5 SUBMITTALS

- A. Submit under provisions of Division 23 Section "Common Results for HVAC - Review of Materials" and Division 01 Section "General Requirements."
- B. Verification Plan.
- C. The Owner or Architect shall provide Performance Tests (PT) procedures for the above listed systems.

PART 2 - PRODUCTS

2.1 VERIFICATION PLAN

- A. The Verification plan shall outline the organization, scheduling, team members, and documentation pertaining to the overall Verification process.

2.2 NARRATIVE DESCRIPTIONS

- A. A narrative description of the design intents of the systems and their intended modes of sequences of operation.

2.3 PERFORMANCE TESTS (PT) PROCEDURES

- A. The FPT procedures at the minimum shall consist of the following sections:
1. Narrative Description:
 - a. This section provides a narrative description of the design intents of the systems and their intended modes of sequences of operation.
 2. Testing Prerequisites:

- a. This section contains verification that primary mechanical, electrical, and controls systems that support or interact with the system that the PT is prepared against are completed, tested and operational.
- 3. Installation Verification:
 - a. This section contains verification that the system installation is completed and is ready for Verification.
- 4. Commencement of Performance Testing:
 - a. This section records the date and time of the start of system Verification.
- 5. System Condition Prior to Starting Performance Testing:
 - a. This section records the current set points and parameters of the system at the start of Verification.
- 6. Performance Test:
 - a. This section shall provide the following:
 - 1) Sequential steps required to set parameters and conditions required to test component and functions throughout intended ranges of operation.
 - 2) Full range of checks and tests carried out to determine if electric and pneumatic connections, components, subsystems, systems and interfaces between systems function in accordance with the contract documents and design intents.
 - 3) All modes and sequences of control operations, interlocks and conditional control responses and specified responses to abnormal emergency conditions.
- 7. End of Performance Test:
 - a. This section records the date and time of the end of system Verification.
- 8. Field Notes:
 - a. This section records notes or remarks during system Verification.
- 9. List systems modifications, not required by the Contract Documents, but provided by the Subcontractor. List other questions regarding such system modifications.
- 10. List problems discovered during Verification that were corrected.
- 11. List problems discovered during Verification that were not corrected.
- 12. List recommended party that should take action on these problems.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractors and Subcontractors shall be responsible for performing procedures presented in specification and contract drawings as detailed in the Performance Tests (PT). Members of the designated Verification Team shall witness various portions of the Verification process. Responsibilities for these activities are listed in the following paragraphs. Verification Team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the Owner or Architect.
- B. Any test ports, gauges, test equipment, etc., needed to accomplish the performance tests shall be provided by Subcontractors.
- C. Subcontractors shall provide to the Verification Team documentation of calibration of controls. Documentation shall include dates, setpoints, calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the work.

3.2 OPERATIONAL STAFF TRAINING

- A. System narrative descriptions will be prepared by the Contractors and supported by flow diagrams, one-line diagrams, and appropriate specification sections for major systems to be verified. The Contractors will coordinate "system description" meetings with the Owner or Architect. The meetings will provide an overview of major system features, components, and arrangements.
- B. The Subcontractor and associated manufacturer's representatives shall provide required training to operational staff after the system description meetings have occurred. The Subcontractor training sessions shall provide a more detailed analogy of systems operation and maintenance.

3.3 INSTRUMENTATION

- A. Instrumentation will be provided by the Subcontractor. Instruments used for measurements shall be accurate. Calibration histories for each instrument shall be available for examination. Calibration and maintenance of instruments shall be in accordance with the requirements of NEBB or AABC Standards.
- B. Application of instruments and accuracy of measurements shall be in accordance with NEBB or AABC Standards.

3.4 DOCUMENTATION

- A. The installing Subcontractor shall be responsible for collection of pertinent data during system start-up and performance testing. The Subcontractor shall submit to the Owner or Architect documentation of tests performed prior to and after system start-up. Documentation shall also include start-up procedures as approved by Owner or Architect.
- B. Documentation is to be typewritten on 8-1/2 by 11 inches (200 by 280 mm) paper and inserted in a 2 inches (50 mm) to 3 inches (75 mm) thick three ring binder. Indicate the project name, number, volume number, and volume title on the end panel of each binder.
- C. Provide a title sheet for each volume and list the following:
 - 1. Volume Title and Section Name and Number requiring this submittal.
 - 2. Project name, project number, and address.
 - 3. Subcontractor name, address, and phone number.
 - 4. Name, title, signature, and date of person making the submittal.
 - 5. Name of University, a blank line for signature, and the date of person accepting the submittal.
 - 6. Name, address, and phone number of Verification Agent; a blank line for signature; and date of person accepting the submittal.
- D. Provide a Table of Contents for multiple submittals. List each submittal and page number. Number each page, centered on the bottom in sequential numerical order. Provide tabs for multiple submittals in a single binder.

3.5 STEP ONE - INSTALLATION VERIFICATION

- A. General Verification responsibilities:
 - 1. Before system start-up begins, the Contractor shall conduct a final installation verification audit. The Subcontractor shall be responsible for completion of work including change orders and punch list items to the Owner or Architect's satisfaction. The audit shall include, but not be limited to, checking of:
 - a. Piping specialties including balance, control, and isolation valves.

- b. Ductwork specialty items including turning devices, balance, fire, smoke, control dampers, and access doors.
 - c. Control sensor types and location.
 - d. Identification of piping, valves, equipment, controls, etc.
 - e. Major equipment, pumps, valves, starters, gauges, thermometers, etc.
 - f. Documentation of prestart-up tests performed, including manufacturer's factory tests.
2. If work is found to be incomplete, incorrect, or non-functional, the Subcontractor shall correct the deficiency before system start-up work proceeds.

3.6 STEP TWO - SYSTEM START-UP

A. General Verification Responsibilities:

1. A start-up plan shall be developed and submitted by the installing Subcontractor. Start-up plan to include the following:
 - a. Flushing and cleaning of pipe.
 - b. Filters, strainers, and screens.
 - c. Valve/damper positions.
 - d. Electrical tests.
 - e. Pressure tests.
 - f. Safeties.
 - g. Chemical treatment.
 - h. Manufacturer's tests.
2. The start-up plan will be reviewed and a prestart-up inspection performed by designated members of the Owner or Architect. The installing Subcontractor shall commence with system start-up after approval has been given to start-up plan and the prestart-up inspection is completed. Designated members of the Verification Team shall witness system start-up and list system and equipment deficiencies noted during start-up. The Subcontractor shall take corrective action on system deficiencies noted and demonstrate to the Verification Team members suitable system operation.
3. Designated systems requiring test and balance work shall have this activity commence after systems have successfully completed start-up. System and equipment deficiencies observed during this activity is to be noted and corrected.

3.7 STEP THREE - PERFORMANCE TESTING

A. General Verification Responsibilities:

1. Performance Testing begins after operational testing, adjusting, and balancing of the systems have been completed by the Subcontractors; and the System Description and Hands-on Training sessions have been completed.
2. The objective of the Performance Testing is to advance the building systems from a state of substantial completion to full dynamic operation in accordance with the specified design requirements and design intent.
3. Attaining this object will be accomplished by developing individual systems testing protocols which, when implemented by the Subcontractor, will allow the Owner or Architect to observe, evaluate, identify deficiencies, recommend modifications, tune, and document the systems and systems equipment performance over a range of load and functional levels.
4. Performance tests for the systems to be verified are defined in the Verification Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.

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 and tubing joining materials.
 - 3. Valves.
 - 4. Pressure regulators.

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, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 65 psig minimum unless otherwise indicated.
 - 3. Minimum Operating Pressure of Service Meter: 5 psig
- B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.
- C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 2. Pressure regulators. Indicate pressure ratings and capacities.
 - 3. Dielectric fittings.

- B. Shop Drawings: For facility natural-gas piping layout. Include 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.
- C. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support 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.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. 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.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

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 Frames."

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. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

3. 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 underground.
4. 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 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. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 1. CWP Rating: 125 psig
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 1. CWP Rating: 125 psig
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
 1. Body: Bronze, complying with ASTM B 584.
 2. Ball: Chrome-plated bronze.
 3. Stem: Bronze; blowout proof.
 4. Seats: Reinforced TFE.
 5. Packing: Threaded-body packnut design with adjustable-stem packing.
 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. CWP Rating: 600 psig.
 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
 2. Plug: Bronze.
 3. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Operator: Square head or lug type with tamperproof feature where indicated.
 5. Pressure Class: 125 psig.
 6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Valve Boxes:
1. Cast-iron, two-section box.
 2. Top section with cover with "GAS" lettering.
 3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
 4. Adjustable cast-iron extensions of length required for depth of bury.
 5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.3 PRESSURE REGULATORS

- A. General Requirements:
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 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. 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.
 8. Maximum Inlet Pressure: 1 psig

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:

1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.5 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.

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. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. 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.
- C. 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. Steel Piping with Protective Coating:
 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 3. Replace pipe having damaged PE coating with new pipe.
- C. Copper Tubing with Protective Coating:
 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- D. Install fittings for changes in direction and branch connections.
- E. Install pressure gage upstream and downstream from each service regulator.

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 natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. 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.

- N. 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.
- O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- P. Connect branch piping from top or side of horizontal piping.
- Q. 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.

- R. Do not use natural-gas piping as grounding electrode.
- S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- T. Install pressure gage upstream and downstream from each line regulator.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors.
- V. Install sleeve seals for piping penetrations of concrete walls and slabs.
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

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.

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.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

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: Green. Refer to section 09 90 00
- 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: Green. Refer to section 09 90 00
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 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.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.13 OUTDOOR PIPING SCHEDULE

- A. Aboveground natural-gas piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG]

- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.

3.15 UNDERGROUND PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Underground natural-gas piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints with scotchkote and wrapped in Pasco pipe protection tape.

3.16 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
 - 1. Two-piece, regular-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- B. Valves in branch piping for single appliance shall be one of the following:
 - 1. Two-piece, regular-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

END OF SECTION

SECTION 23 2300
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other Sections of Division 23.

1.2 SUMMARY

- A. Section includes:
 - 1. Pipes, tubing, fittings, and specialties.
 - 2. Special duty valves.
 - 3. Refrigerants.
 - 4. Installation of refrigerant piping.
- B. Products installed but not furnished under this Section include pre-charged tubing, refrigerant specialties, and refrigerant accessories furnished as an integral part of packaged air conditioning equipment.
- C. Design and installation shall be provided in accordance with equipment manufacturer's recommendations.
- D. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Section 23 05 00 - "Common Work Results for HVAC": Labeling and identification of refrigerant piping.
 - 2. Section 23 05 29 - "Hangers and Supports for HVAC Piping and Equipment."
 - 3. Section 23 05 53 - "Identification for HVAC Piping and Equipment."
 - 4. Section 23 07 00 - "HVAC Insulation": Pipe insulation.
 - 5. Section 23 05 93 - "Testing, Adjusting and Balancing for HVAC."
 - 6. Section 23 81 43 - "Air Source Unitary Heat Pumps."

1.3 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.
- B. Product data for the following products:
 - 1. Each type valve specified.
 - 2. Each type refrigerant piping specialty specified.
- C. Submit Shop Drawings showing design and layout of refrigerant piping, valves, expansion valves, drains accumulators, traps, filters, and miscellaneous specialties, etc. Shop Drawings shall also include but not necessarily be limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and proximate to equipment. Provide a letter from the equipment manufacturer certifying the design is being provided in accordance with the equipment manufacturer's

criteria.

- D. Brazer's Certificates signed by Contractor certifying that brazers comply with requirements specified under "Quality Assurance" below.
- E. Maintenance data for refrigerant valves and piping specialties, for inclusion in Operating and Maintenance Manual specified in Division 01 and in Section 23 05 00 - "Common Work Results for HVAC."

1.4 QUALITY ASSURANCE

- A. Qualify brazing processes and brazing operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications".
- B. Regulatory Requirements: Comply with provisions of the following codes:
 - 1. ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping, latest edition.
 - 2. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration, latest edition.
 - 3. International Mechanical and Plumbing Codes, 2009.
 - 4. PHCC: National Standard Plumbing Code, latest edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Refrigerant Valves and Specialties:
 - a. Alco Controls Div, Emerson Electric.
 - b. Danfoss Electronics, Inc.
 - c. EATON Corporation, Control Div.
 - d. Henry Valve Company.
 - e. Parker-Hannifin Corporation, Refrigeration and Air Conditioning Division.
 - f. Sporlan Valve Company.

2.2 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3, Article "Pipe Application" for identification of systems where the below specified pipe and fitting materials are used.
- B. Copper Tubing: ASTM B 280, Type ACR, hard-drawn straight lengths, and soft-annealed coils, seamless copper tubing. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.

2.3 FITTING MATERIALS

- A. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.

2.4 JOINING MATERIALS

- A. Brazing Filler for Joining Similar Metals: AWS A5.8, Classification BCuP series, with melting range from 1190 to 1480°F.
- B. Brazing Filler for Joining Dissimilar Metals: AWS A5.8, Classification BAg series, with melting range from 1125 to 1370°F.

2.5 VALVES

- A. General: Complete valve assembly shall be UL-listed and designed to conform to ARI 760.
- B. Globe: 450 psig maximum operating pressure, 275°F maximum operating temperature; cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through or angle pattern, with solder-end connections.
- C. Check Valves - Smaller Than 7/8 inch: 500 psig maximum operating pressure, 300 °F maximum operating temperature; cast brass body, with removable piston, Teflon seat, and stainless steel spring; straight through globe design. Valve shall be straight through pattern, with solder-end connections.
- D. Check Valves - 7/8 inch and Larger: 450 psig maximum operating pressure, 300°F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.
- E. Solenoid Valves: 250°F temperature rating, 400 psig working pressure; forged brass, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with 1/2 inch conduit adapter, and 24 volt, 60 Hz. normally closed holding coil.
- F. Evaporator Pressure Regulating Valves: pilot-operated, forged brass or cast bronze; complete with pilot operator, stainless steel bottom spring, pressure gage tappings, 24 volts DC, 50/60 Hz, standard coil; and wrought copper fittings for solder end connections.
- G. Thermal Expansion Valves: thermostatic adjustable, modulating type; size as required for specific evaporator requirements, and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder end connections; complete with sensing bulb, and an external equalizer line.

2.6 REFRIGERANT PIPING SPECIALTIES

- A. General: Complete refrigerant piping specialty assembly shall be UL-listed and designed to conform to ARI 760.
- B. Strainers: 500 psig maximum working pressure; forged brass body with monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.
- C. Moisture/liquid Indicators: 500 psig maximum operation pressure, 200°F maximum operating temperature; forged brass body, with replaceable polished optical viewing window, and solder end connections.
- D. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including gaskets, as follows:
 - 1. Standard capacity desiccant sieves to provide micronic filtration.
- E. Suction Line Filter-Drier: 350 psig maximum operation pressure, 225°F maximum operating temperature; steel shell, and wrought copper fittings for solder end

connections. Permanent filter element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.

- F. Suction Line Filters: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter core kit, including gaskets, as follows:
- G. Flanged Unions: 400 psig maximum working pressure, 330°F maximum operating temperature; two brass tailpiece adapters for solder end connections to copper tubing; flanges for 7/8 inch through 1-5/8 inch unions shall be forged steel, and for 2-1/8 inch through 3-1/8 inch shall be ductile iron; four plated steel bolts, with silicon bronze nuts and fiber gasket. Flanges and bolts shall have factory-applied rust-resistant coating.
- H. Flexible Connectors: 500 psig maximum operating pressure; seamless tin bronze or stainless steel core, high tensile bronze braid covering, solder connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inch in length.
- I. Suction Accumulators: Provide as manufactured by Refrigeration Research, Inc.

2.7 REFRIGERANT: Type shall be provided to suit equipment being served.

2.8 LOCKING ACCESS PORT CAPS

- A. Provide locking cap(s) with multi-key(s) for all refrigerant circuit access ports located outdoors.
- B. Locking caps shall be as manufactured by Win Air Company or comparable acceptable product.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation.

3.2 PREPARATION

- A. Pre-Cleaning:
 - 1. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:
 - a. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
 - b. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - c. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - d. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Hangers, supports, and anchors are specified in Section 23 05 29 - "Hangers and Supports for HVAC Piping and Equipment."

3.4 INSTALLATION OF VALVING

- A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.
- B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere in accordance with manufacturer's instructions.
- C. Install a full sized, 3-valve bypass around each drier.
- D. Install solenoid valves ahead of each expansion valve. Install solenoid valves in horizontal lines with coil at the top.
 - 1. Electrical wiring for solenoid valves is specified in Division 26. Coordinate electrical requirements and connections.
- E. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.
 - 1. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.
 - 2. Install the valve in such a location so that the diaphragm case is warmer than the bulb.
 - 3. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.
 - 4. Where external equalizer lines are required, make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.
- F. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

3.5 PIPING APPLICATION

- A. Provide Type ACR drawn copper tubing with wrought copper fittings and brazed joints above ground, within building. Provide Type K, annealed temper copper tubing for 2 inch and smaller without joints, within enclosed areas. Mechanical fittings (crimp or flair) are not permitted.
 - 1. Install annealed temper tubing in pipe duct. Vent pipe duct to the outside.

3.6 INSTALLATION OF PIPING

- A. Size piping and install refrigerant piping, traps, specialties as necessary for a complete and operational system in accordance with equipment manufacturer's recommendations.
- B. General: Install refrigerant piping in accordance with ASHRAE Standard 15 "The Safety Code for Mechanical Refrigeration". Unless specified otherwise by the Section, comply with "Installation of Piping - General" as specified in Section 22 05 03 - "Pipes and Tubes for Plumbing Piping and Equipment" and Section 23 05 03 - "Pipes and Tubes for HVAC Piping and Equipment."
- C. Install piping in as short and direct arrangement as possible to minimize pressure drop.
- D. Install piping for minimum number of joints using as few elbows and other fitting as possible.

- E. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.
- F. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.
- G. Insulate suction lines. Insulate liquid lines located outside the building. Liquid lines inside the building are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.
 - 1. Do not install insulation until system testing has been completed and all leaks have been eliminated.
- H. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.
- I. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.
- J. Slope refrigerant piping as follows:
 - 1. Install horizontal hot gas discharge piping with 1/2" per 10 feet downward slope away from the compressor.
 - 2. Install horizontal suction lines with 1/2" per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
 - 3. Install traps and double risers and where required in accordance with equipment manufacturer's recommendations to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- K. Use fittings for all changes in direction and all branch connections.
- L. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- M. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- N. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- O. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- P. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- Q. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal.

- R. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 07 for special sealers and materials.
- S. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.
- T. Install strainers immediately ahead of each expansion valve, solenoid valve, compressor suction valve, and as required to protect refrigerant piping system components.
- U. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver.
 - 1. Install moisture/liquid indicators in lines larger than 2 1/8" OD, using a bypass line.
- V. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.
- W. Install flexible connectors at the inlet and discharge connection of compressors.
- X. Refrigerant circuit access ports located outdoors shall be fitted with locking-type-tamper-resistance caps.

3.7 CONSTRUCTION

- A. Pipe Joints:
 - 1. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
 - a. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
 - b. CAUTION: When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do not apply heat near the bulb of the expansion valve.
 - 2. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.
 - 3. Heat joints using oxy-acetylene torch. Heat to proper and uniform brazing temperature.
 - 4. All refrigerant piping shall be phosphor copper brazed and not flux brazed.
- B. Equipment Connections:
 - 1. The Drawings indicate the general arrangement of piping and fittings.
 - 2. Install piping adjacent to machine to allow servicing and maintenance.

3.8 REFRIGERANT PIPING SYSTEMS

- A. Inspect, test and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI, "Refrigerant Piping and Heat Transfer Components", 2001, and as follows:
 - 1. All refrigerant tubing shall be tested before tube insulation is applied.

2. Note: The use of compressed air for pressure testing refrigerant tubing will not be permitted.
3. Refrigerant relief valves, if installed, shall be removed prior to pressure testing and shell openings plugged. After system is tested and found to be completely tight, relief valves shall be reinstalled prior to system evacuation.
4. Each tubing system shall be pressure tested with dry nitrogen. Leaks shall be repaired by removing and remaking the defective joint. No caulking will be permitted. After repair of leaks, system shall be retested and provided tight.
5. Tubing shall be tested as a minimum of 550 psig for a 24 hour period. Suggested procedure is as follows:
 - a. Charge system with oil pumped dry nitrogen to a pressure of 100 psig. Make a soap bubble test of all joints and all connections. Mark all leaks, blow down and repair all leaks.
 - b. After above test and repair, charge high side with R-507 or R-12, R-22 or R-502 gas (based upon application) to a pressure of 30 psig. Make a rapid leak check at this pressure using an electronic leak detector. If no leaks are found, raise pressure to 550 psig using oil pumped dry nitrogen.
 - c. Leave nitrogen and refrigerant mixture overnight to permit mixing by diffusion. Check diffusion and leak tester operation by venting a flange or valve stem. Make a thorough leak test. If leaks are found, blow down, repair and retest. Continue this procedure until entire system is provided to be absolutely tight.
 - d. After the refrigerant piping has been pressure tested and proven tight, and before piping insulation is applied, the entire system shall be evacuated with a vacuum pump to remove air and moisture. Evacuation shall be performed with all spaces containing refrigerant piping or equipment at no lower than 50°F.
 - e. Manual valves except those open to atmosphere shall be opened and all controls such as solenoids shall be jacked open. Any gauges or pressure controls which could be damaged by a deep vacuum shall be valved off. Seal caps on valves shall be in place and tight. Any valves open to atmosphere shall be closed and capped.
 - f. The entire system shall be double evacuated to 1500 microns Hg absolute (1.5 torr) as follows:
 - 1) When vacuum pump is started, vacuum should pull down fairly rapidly to 25,000 microns Hg absolute (28.94"). If vacuum does not pull below 25,000 microns, there are leaks in the system and leak test procedure must be repeated.
 - 2) At approximately 10,000 microns, evaporation of free water in the system will be rapidly accelerated and vacuum will tend to remain constant as evaporation rate begins to equal vacuum pump capacity. Depending on amount of water, ambient temperature and vacuum pump capacity, it may take several hours to make any noticeable decrease in vacuum below 10,000 microns. During this period, apply heat to any low points or suspected points of moisture. Feel pipes for cold spots and supply heat.
 - 3) Continue evacuation until a pressure of 1,500 microns (1.5 torr) minimum is reached, then break the vacuum and pressurize to 10 psig with oil pumped dry nitrogen as a holding charge until ready for charging.
 - 4) When ready for charging, vent nitrogen holding charge to atmosphere and re-evacuate down to a minimum of 1,500 microns. Break vacuum with refrigerant gas. Do not use liquid.
 - g. Repair leaking joints using new materials, and retest for leaks.

3.9 ADJUSTING AND CLEANING

- A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- B. Clean and inspect refrigerant piping systems in accordance with industry standards.
- C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.10 SYSTEM START-UP

- A. Charge system using the following procedure:
 - 1. Install core in filter dryer after leak test but before evacuation.
 - 2. Evacuate refrigerant system with vacuum pump; until temperature of 35°F is indicated on vacuum dehydration indicator.
 - 3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
 - 4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
 - 5. Break vacuum with refrigerant gas; allow pressure to build up to 2 psi.
 - 6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.
- B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties. Training shall be a minimum of eight (8) hours performed during a regular business day with a one hour lunch break. Record all training sessions. Provide the owner with three (3) copies in digital versatile disk (DVD) format.
- C. Review data in Operating and Maintenance Manuals. Refer to the Division 01 Specifications.
- D. Schedule training with Owner through the Architect, with at least seven (7) days advance notice.

END OF SECTION

SECTION 23 3000

HVAC AIR DISTRIBUTION

PART 1 - GENERAL

1.1 GENERAL

- A. All work under this section shall also be subject to the Requirements of Section 23 05 00, "Common Work Results for HVAC."
- B. The fabrication and installation of all ductwork, together with related equipment shall comply with the standards of the National Fire Protection Association, as set forth in NFPA Standard No. 90A, as well as with the requirements of the Sheet Metal and Air Conditioning Installer's Association, Inc. and the latest edition of the ASHRAE Guide.
- C. All duct sizes shown are net inside clear dimensions. Where internal duct lining is used, increase duct sizes accordingly to provide the indicated net free area. Unless otherwise indicated, size runouts, drops and connections to grilles, registers, diffusers, fans, water-source heat pump units, split system air handling units, louvers, filters and other equipment to the full size of the equipment connection.
- D. Minor changes may be made in duct sizes where required to fit the available space, provided the indicated net free area and approximate aspect ratio are maintained.
- E. Smoothly transition all ductwork and prevent excessive or unnecessary turbulence or pressure loss.
- F. Submit sheet metal fabrication shop drawings.
- G. All ductwork shall be cleaned following fabrication using filtered compressed air and the ends shall be sealed at the shop. Upon delivery to the site, duct ends shall remain sealed until time of actual installation. Following installation, ductwork shall be wiped down and cleaned (swept/vacuumed) in place. Partially installed ductwork shall have unfinished areas resealed in place at the end of each working day.

PART 2 - PRODUCTS

2.1 DUCTWORK

- A. Unless otherwise indicated or specified, fabricate ductwork of galvanized sheet steel or aluminum, conforming to Commercial Designation 3003 Temper H14 and Duct Sheet. Duct gauges, jointing and reinforcement shall conform to Tables 4, 5, 6 and 7 as applicable, Chapter 1 of 1975 ASHRAE Guide and Data Book and SMACNA HVAC Duct Construction Standards - Metal and Flexible - 1985. Construction for Ventilation and Air Conditioning Systems as published by Sheet Metal and Air Conditioning Installer's Association, Inc.
- B. Erect sheet metal ductwork in a first class, workmanlike manner secured in place rigidly and permanently. Provide suitable hangers, securely attached to building construction with bolts, clips or inserts. Hangers shall be structural shapes, flat bars or formed strap hangers; use of wire will not be permitted. Hangers shall not pass through or be inside duct. Support vertical ducts passing through floors by angles riveted to duct and resting either on floors or on brackets secured to building construction. All space around duct where they pass through walls, floors, ceilings or roofs shall be sealed tight with

incombustible inert material. Do not arrange ducts so as to impair the effectiveness of fireproofing around exposed ducts passing through walls, floors or ceilings in finished areas to provide finished appearance. Provide sheet metal flanged collars around all exposed ducts passing through walls, floors or ceilings in finished areas to provide finished appearance. Seal all duct joints and seams including low pressure supply and return and exhaust ductwork with Hardcast Two Part Sealing System as manufactured by Hardcast, Inc. and no others will be acceptable. Two part sealing system shall consist of DT-TAPE with RTA-50 indoor/outdoor sealing system.

- C. Flexible connections of neoprene or other NFPA approved non-inflammable fabric shall be provided in duct system at all fan inlet and outlet connections.
- D. Provide duct turning vanes in all cut turns where center line radius is less than 1½ times width of duct and in all square elbows. Turning vanes shall be airfoil type with extended trailing edges.
- E. Provide duct collars and angle iron framework for mounting of automatic dampers.

2.2 DUCT SYSTEM

- A. Duct system shall be constructed as specified below.
 - 1. Supply and return ductwork: 2" w.c. galvanized sheet metal duct construction. Flexible or galvanized sheet metal ductwork from duct branch to diffusers as indicated on plans.
 - 2. All ductwork serving the corridor ventilation system: galvanized steel 2" W.C. construction.
 - 3. Outdoor Air Ductwork: 2" w.c. duct construction.
 - 4. Supply duct serving apartments except on highest floor: 1-1/2" thick duct board.
 - 5. Supply duct serving apartments on highest floor: galvanized steel 2" W.C. construction.

2.3 DUCT CONSTRUCTION

- A. Round Ductwork: Ductwork shall be single wall Type SS(75) as manufactured by Semco Manufacturing, Inc. or approved equal, uniseal duct and uniform fittings. Construct ductwork of galvanized sheet steel. Elbows 8" diameter and smaller shall be smooth formed. Larger elbows shall be 5 section type. Tees and crosses and laterals shall be conical. Make joints with sleeve type couplings, short length sheet metal screws and duct sealant. Conform to duct manufacturer's recommendations for jointing and installation. Ductwork and fittings shall be manufactured by a company regularly engaged in the construction of spiral ductwork and fittings. Manufacturers substituted for the above specified manufacturers shall submit for approval, independent published laboratory test data on all proposed ductwork and fittings showing materials of construction, air flow, pressure drop and acoustical performance characteristics.
- B. Rectangular Ductwork (2" w.g. construction):
 - 1. Make allowance for internal duct lining where required.
 - 2. Determine duct gauges for the longest duct side and use for all 4 sides. Joints and reinforcing requirements apply to the longest duct side.
 - 3. Reinforce all ducts to prevent buckling, vibration or noise as recommended in the referenced construction standards and as required to suit the installed conditions.
 - 4. Do not crossbreak duct which will receive rigid insulation covering.
 - 5. Where tap sizes of divided flow fittings are not indicated, make branch and main connection sizes proportional to their respective air flows and maintain uniform

- transverse velocities in the fittings.
6. Make radius elbows and radius tee connection with throat radius equal to or greater than the width of the duct. Use vaned elbows where shown and where radius elbows will not fit the space in all square bends.
 7. Turning vanes shall be the airfoil type with extended trailing edges 36" maximum length. Where longer vanes are required, use 2 or more sets of vanes with intermediate runners securely fastened together.
 8. Bolts, screws, rivet or spot weld reinforcing members securely to the duct on not less than 6" centers.
 9. Where ducts are open ended without grilles, registers or other means of stiffening, reinforce and stiffen the open end with standing seams or an angle frame.
 10. Paint all cut ends on galvanized angles, rods and other uncoated surfaces with aluminum paint.
 11. Where ductwork is not painted or otherwise finished, remove all exposed traces of joint sealers, manufacturer's identification and other markings.
 12. Aluminum sheet shall be 3003 H14 alloy or duct sheet, 16,000 PSI minimum tensile strength and capable of being formed to a Pittsburgh lock seam.
 13. Reinforcing members for aluminum ductwork may be galvanized steel or aluminum, unless otherwise indicated. Where aluminum reinforcing is used, size the member in accordance with ASHRAE recommendations to have rigidity equivalent to listed mild steel angle sizes.
 14. Where aluminum ductwork is used, make allowance for increased thermal expansion. Particularly avoid direct contact between aluminum and concrete or masonry walls subject to dampness.

C. 1-1/2" Thick Duct Board (only permitted where shown on plans)

1. Duct board shall be constructed of durable fiber glass fibers bonded with thermosetting resin. The airstream side of the duct board shall have a black fiber glass mat. The exterior surface shall have a fire resistant facing to extend the full width of the male edges to serve as an integral closure flap for section joints.
2. Duct board shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 and meet standard ASTM E84, UL 723 and NFPA 90A and 90B.
3. Maximum K-Factor: 0.23 at 75° F.
4. Minimum thermal performance: R-value of 6.

2.4 AIR VOLUME CONTROLS

- A. Provide air volume control devices where indicated and where required to adjust and balance air flow in the systems.
- B. Air extraction for air outlets and branch ducts shall be the gang operated vane type, Tuttle & Bailey - Vectrol, Type VLC or VLK as appropriate or approved equal, with suitable adjusting device and means of access.
- C. Manual volume dampers in ductwork shall be factory assembled units with rigid frame, opposed blade action and locking quadrant operator. Mark the extended damper shaft and align the operating handle to indicate the blade position. Dampers shall be as manufactured by American Warming and Ventilating, Inc., Ruskin or approved equal. Rectangular dampers shall be Type DAA-P-50, with steel channel frame, 16 gauge steel blades, 9" maximum blade spacing, nylon bearings, galvanized finish with aluminum paint touch up.

- D. Automatic temperature control (ATC) dampers shall be as hereinafter specified under Section 23 09 00, "Instrumentation and Control for HVAC".
- E. Duct turning vanes shall be Tuttle & Bailey Ductturns or approved equal.
- F. Furnish and install duct collars and angle iron frames for the installation of ATC dampers.

2.5 DUCT ACCESS DOORS

- A. Furnish and install adequately sized duct access doors, at coils, automatic dampers and other locations where indicated and required for duct access. Doors shall be the hinged type with approved latches and neoprene compression type gaskets. Stiffen ductwork at door openings where doors are installed in insulated ductwork, provide equivalent insulation in the door assembly. Where access doors are installed in fire rated partitions, provide fire seal access doors as manufactured by Air Balance, Inc. or approved equal, UL approved, meeting the rating of the enclosure in which the access door is installed.

2.6 FLEXIBLE DUCT

- A. Flexible ductwork shall be Atco UPC #080 or approved equal, UL listed for Class 1 Air Ducts, Standard 181. Ducts shall be rated for 10" W.G. per UL 181.
- B. Limit flexible duct 6' maximum. Install flexible ducts, using all recommended fittings, couplings and accessories. Support ducts with wide straps spaced so that horizontal runs do not sag more than 3" in 3'. Cover with duct tape and fasten with duct strap clamps. 180°F bends in flexible duct are prohibited.

2.7 AIR TERMINAL DEVICES

- A. Furnish and install air supply, return and exhaust devices of sizes and capacities as scheduled on the contract drawings. Unless otherwise indicated, catalog numbers shown are Titus products and for equipment which has been found suitable for the application. Products of Hart & Cooley/Tuttle & Bailey Inc., Carnes or Krueger will be considered only if performance characteristics, including throw, drop, pressure loss, sound pressure level, etc. are equal to or better than the performance characteristics of the specified product. Performance characteristics as indicated above shall be included in shop drawing submittals. Shop drawings will not be reviewed unless performance data is submitted.
- B. Refer to the contract drawings for information on air terminal basis of design model number, sizes and capacities and direction of throw.
- C. Where air terminal devices are installed in duct collars or branches, furnish and install air extractors. Furnish and install control grids, volume dampers and/or other accessories necessary to ensure uniform air flow across the terminal devices. Accessories shall be of the same material as the terminal device. Install fixed blade terminals so that blades block the normal line of vision. Furnish 3 of each type of removable key operators.

2.8 DUCT THERMOMETERS

- A. Duct thermometers shall be Johnson Service Co., Powers Regulator Co. or approved equal, 4½" dial, 2°F divisions, cast aluminum case, mercury actuated, brass movement, 8' copper averaging bulb with bronze braided armor, stainless steel connecting tube as required.
- B. Duct thermometers shall be furnished and installed at air handling units as follows:

| LOCATION | RANGE |
|------------------|----------------|
| Outdoor Air Duct | -40°F to 120°F |
| Return Air Duct | 30°F to 180°F |
| Mixed Air Plenum | 30°F to 180°F |
| Supply Air Duct | 30°F to 180°F |

2.9 SPIN-IN FITTINGS

- A. Furnish and install spin-in fittings where indicated on the contract drawings, Buckley Air-Tite Bellmouth Model BM with balancing damper as manufactured by Buckley Air Products, Inc. or approved equal.

2.10 SMOKE DETECTORS

- A. Smoke detectors and associated wiring shall be provided under Division 26 and located and installed under this division.

2.11 FIRE DAMPERS

- A. Furnish and install automatic fire dampers where indicated and where required by NFPA Standard No. 90A and by the Fire Marshal of the State of Colorado and the Fire Marshal of Loudon County.
- B. Construction of fire dampers shall conform to requirements of NFPA No. 90A and shall bear UL label. Fire dampers shall be set in frames adequately secured to fire partitions, floors, etc. and installed in strict accordance with UL 555 listing and manufacturer's instructions.
- C. Fire dampers basis of design shall be Air Balance, Inc. Comparable products as manufactured by United Sheet Metal or Ruskin shall be submitted for approval as a comparable product. Fire dampers shall be multi-leaf accordion type, held open by adequate heavy gauge wires and suitable calibrated fusible links. Vertical dampers (horizontal air flow) shall close by gravity. Horizontal dampers (vertical air flow) shall be closed by suitable and positive spring closing devices.
- D. Damper frames shall provide pocket which shall store damper leaves in open position outside of air stream and shall provide 100% free air flow when open, Type B fire dampers.
- E. Provide adequately sized hinged access doors with cam locks for access to all fusible links and for resetting fire dampers. Where applicable, access to fire dampers shall be through registers or grilles.
- F. Submit complete information to the Engineer, including installation details.
- G. Behind air devices, provide thin line fire dampers where indicated shall be Ruskin (Type A), curtain type with 1-7/8" galvanized steel frame, 18 gauge steel enclosure with UL 555 label, rated for wall in which being provided. Dynamic "Curtain blade" fire dampers shall not be acceptable, Static type shall be utilized.
- H. Furnish to the Owner in a suitable storage container not less than 6 fusible links of each type, size and rating used on the project.

2.12 COMBINATION FIRE / SMOKE DAMPERS

- A. Furnish and install combination fire/smoke dampers where indicated and where required by NFPA Standard No. 90A, 92A and 92B and by the Fire Marshal of the State of Colorado, and by the Fire Marshal of Loudon County.
- B. Construction of combination fire/smoke dampers shall conform to requirements of NFPA No. 90A, 92A and 92B and shall be classified for use for fire resistance ratings of less than 3 hours, in strict accordance with UL 555 listing and manufacturer's instructions. Dampers shall further be classified as Smoke Dampers in accordance with the latest version of UL555S. The leakage rating under UL555S shall be leakage Class 2.
- C. Combination fire/smoke dampers basis of design shall be Ruskin. Comparable products as manufactured by United Sheet Metal or Air Balance, Inc. shall be submitted for approval as a comparable product. Submit complete information to the Engineer, including installation details.
- D. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 250 F (121 °C) or 350 °F (177 °C) depending upon the actuator. Appropriate electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Electric actuators shall have been energized hold open tested for a period of at least 1 year with no spring return failures. Damper and actuator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Each damper shall be rated for leakage and airflow in either direction through the damper.
- E. Each combination fire/smoke damper shall be equipped with a "controlled closure" quick detect heat-actuated release device to prevent duct and HVAC component damage. Instantaneous damper closure is unacceptable.
- F. Damper frame shall be minimum 16 (1.6) gage galvanized steel formed into a structural hat channel reinforced at corners. Damper blades shall be single skin galvanized steel 16 (1.60) gage minimum with three longitudinal grooves for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seals shall be inflatable silicone coated fiberglass and galvanized steel mechanically locked into blade edge (adhesive or clip on seals not acceptable). Jamb seals shall be stainless seals compression type. Each damper shall be supplied with a factory mounted sleeve of 17" (432) minimum length.
- G. Provide damper with required end switch appropriate for monitoring damper position while maintaining UL Listing.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Coordinate ductwork with other work and install ducts at proper elevations and locations to maintain indicated ceiling heights and clearances. Provide all elbows, transitions, offsets, connections and other fittings necessary to fit the work into place or to connect to equipment of diffusers. Method of duct support connection to structure and slabs shall be approved by the Architect; submit shop drawings.
- B. Substantially support ductwork with structural shapes, flat bars or formed strap hangers securely attached to the building structure by means of bolts, clamps or inserts. Support vertical ducts by angles attached to the duct and resting on the floor or supported by brackets or hangers attached to the building structure. Strap hangers shall be 16 gauge minimum galvanized steel formed under the bottom edge of duct. Use square ¼" thick washers tight against the bend on upper strap attachments to horizontal surfaces. Place

all supports external to the ductwork and out of the air stream. Provide additional supports at coils and other concentrated loads. Arrange supports so that duct weight is not transmitted to ceilings, fans or other equipment.

- C. Prevent direct contact between ductwork and building surfaces or other equipment. Where ducts pass through walls, partitions, floors, ceilings or roofs, pack and seal the space around the duct with an approved fire safe inert material.
- D. Use galvanized or corrosion resistant hangers, supports, brackets and hardware.
- E. Furnish and install NFPA approved flexible duct connections where shown and at all connections to fans. Use glass reinforced neoprene fabric, roll formed to sheet metal strips or flanges. Support adjacent ductwork to provide sufficient slack in the connection.

3.2 LEAKAGE TESTS

- A. All sheet metal ductwork shall undergo leakage tests according to duct construction ratings. Tests shall be accomplished under this section and witnessed as specified under Section 23 05 95 "Leak Testing, Air Distribution and Duct Systems."
- B. Leakage from each duct system shall not exceed 5% of the normal air handling capacity of the system. If the system ductwork is tested in sections, repair all leaks which are audible, regardless of the leakage rate of the duct system as a whole, by remaking the entire defective joint or seam. Spot sealing of ducts in place will be unacceptable.
- C. Submit a complete report of ductwork leakage test to the Architect.

3.3 DUCTWORK CLEANING

- A. All ductwork shall be cleaned following fabrication using filtered compressed air and the ends shall be sealed at the shop. Upon delivery to the site, duct ends shall remain sealed until time of actual installation. Following installation, ductwork shall be wiped down and cleaned (swept/vacuumed) in place. Partially installed ductwork shall have unfinished areas resealed in place at the end of each working day.

END OF SECTION

SECTION 23 3400

HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to this section, and all sections of Division 23.

1.2 SUMMARY

- A. Section Includes:

1. Centrifugal roof mounted make up air unit.
2. Wall mounted propeller fans.
3. Upblast centrifugal roof fans.
4. Centrifugal wall fans.
5. Ceiling fans.
6. Inline ceiling fans.
7. Centrifugal square inline cabinet fans.

- B. Related Sections: The following sections contain requirements that relate to this section:

1. Section 23 05 14 - "Common Motor Requirements": Product requirements for motors for placement by this section.
2. Section 23 05 48 - "Vibration and Seismic Controls for HVAC Piping and Equipment": Product requirements for resilient mountings and snubbers for fans for placement by this section.
3. Section 23 07 00 - "HVAC Insulation": Product requirements for power ventilators for placement by this section.
4. Section 23 30 00 - "HVAC Air Distribution."
5. Section 23 09 00 - "Instrumentation and Control for HVAC": Product requirements for control components to interface with fans.
6. Section 26 05 19 - "Low Voltage Electrical Power Conductors and Cables:" Requirements for electrical wiring and cable connections for units specified in this section.
7. Section 26 05 33 - "Raceways and Boxes for Electrical Systems:" Requirements for electrical conduits and boxes housing electrical wiring and connections specified by this section.

1.3 REFERENCES

(Unless otherwise noted, references apply to "latest editions.")

- A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

- B. Air Movement and Control Association International, Inc.:

1. AMCA 99 - Standards Handbook.
 2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. American Refrigeration Institute:
1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.
- D. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.
 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. Underwriters Laboratories Inc.:
1. UL 705 - Power Ventilators.

1.4 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the Contract and Division 01 specification sections.
- B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.
- C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Provide closeout documentation in accordance with the Division 01 Specification Sections.
- B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

- D. Balance Quality: Conform to AMCA 204.
- E. Perform Work in accordance with all applicable codes, standards and local authorities having jurisdiction requirements.
- F. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience and service facilities within 50 miles of the project.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept fans and components on site in factory protective containers, with factory shipping skids and lifting lugs, inspect for damage.
- B. Protect motors, shafts, and bearings from weather and construction dust.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Furnish one year manufacturer's warranty for fans.

1.11 MAINTENANCE SERVICE

- A. This applies to all fans except those located in the apartments.
- B. Furnish service and maintenance of fans for five years from Date of Substantial Completion.
- C. Examine each fan's components bi-monthly. Clean, adjust, and lubricate equipment.
- D. Include systematic examination, adjustment, and lubrication of fans, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- E. Perform work without removing fans from service during building normal occupied hours.
- F. Provide emergency call back service at all hours for this maintenance period.
- G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
- H. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.

- I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.12 EXTRA MATERIALS

- A. Furnish two sets of belts for each belt driven fan.

PART 2 - PRODUCTS

2.1 WALL MOUNTED PROPELLER FANS

- A. Belt Drive Sidewall Mounted Propeller Fan:

- 1. Manufacturer:
 - a. Fans shall meet model numbers, types, sizes, capacities and electric characteristics as indicated on the contract drawings. Acceptable manufacturers: Greenheck, Cook, Penn Ventilator or Twin City Blower Company.
 - b. Belt Drive Sidewall Mounted Propeller Fan:
 - 1) Fan arrangement shall be either supply or exhaust, refer to contract drawings for arrangement.
 - 2) Fans shall be suitable for maximum continuous operating temperature 130 Fahrenheit (54.4 Celsius).
 - 3) Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.
 - c. Wheel:
 - 1) Material type steel blades and hubs.
 - 2) Securely attached to fan shaft with standard square key and set screw or tapered bushing.
 - 3) Wheel shall be statically and dynamically balanced in accordance with AMCA Standard 204-05.
 - 4) The propeller and fan inlet shall be matched and shall have precise running tolerances for maximum performance and operating efficiency.
 - d. Motors:
 - 1) Motor enclosures shall be open drip proof.
 - 2) Motors shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
 - 3) Motors shall be accessible for maintenance.
 - e. Shafts and Bearings:
 - 1) Fan Shaft shall be ground and polished solid steel with an anti corrosive coating.
 - 2) Bearing shall be stamped steel or cast pillow block.
 - 3) Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - 4) Bearings shall be air handling quality and shall be 100% factory tested by bearing manufacturer.
 - 5) Fan Shaft first critical speed is at least 25 percent over maximum operating speed.
 - f. Drive Frame:
 - 1) Drive frame assemblies shall be galvanized steel, and bolted construction.

- 2) Drive frame shall have formed channels and fan panels shall have prepunched mounting holes, formed flanges and a deep formed one piece inlet venturi.
- a. Disconnect Switches:
 - 1) Disconnect shall be:
 - a) NEMA 1: indoor application no water: factory standard
- b. Drive Assembly:
 - 1) Belts, pulleys, and keys shall be oversized for a minimum of 150 percent of driven horsepower.
 - 2) Belts shall be Static free and oil resistant.
 - 3) Shall have fully machined cast iron pulleys, keyed and securely attached to the wheel and motor shafts.
 - 4) The motor pulley shall be adjustable for final system balancing.
 - 5) Motor shall be readily accessible for maintenance.
- c. Options/Accessories:
 - 1) Closure Angles:
 - a) Provide extra set of mounting flanges for field installation to close off the interior wall opening for a finished appearance.

2.2 CEILING FANS

A. Direct Drive Premium Ceiling Mounted Centrifugal Exhaust Fans:

- 1. Manufacturer:
 - a. Fans shall meet model numbers, types, sizes, capacities, and electrical characteristics as indicated on the contract drawings. Acceptable manufacturers: Greenheck, Cook, Penn Ventilator or Twin City Blower Company.
- 2. General:
 - a. Maximum operating temperatures shall be 130 Fahrenheit (54.4 Celsius).
 - b. Sound levels shall be as low as 0.7 AMCA sones.
 - c. Shall be UL/cool listed for above bathtub exhaust.
 - d. Fans shall be UL/cUL listed 507 - Electric Fans.
 - e. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number.
- 3. Wheel:
 - a. Shall be forward curved centrifugal wheel.
 - b. Shall be constructed of galvanized steel or calcium carbonate filled polypropylene.
 - c. Shall be statically and dynamically balanced in accordance to AMCA Standard 204-05.
- 4. Motors:
 - a. Motor enclosures shall be open driproof (ODP), opening in the frame body and or end brackets.
 - b. Motor shall be permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase.
 - c. Motor shall be mounted on vibration isolators and be accessible for maintenance.
 - d. Shall come with thermal overload protection.
- 5. Housing:
 - a. Shall be constructed of heavy gauge galvanized steel.
 - b. Interior shall be lined with 0.5 inches of acoustical insulation.
 - c. Profile shall be as low as 10 ½ inches.
- 6. Provide Spring Loaded Aluminum Backdraft Damper:

7. Outlet:
 - a. Shall be field rotatable from horizontal to vertical discharge.
 - b. Duct collar shall include an aluminum backdraft damper.
8. Grille:
 - a. Types: Aluminum
 - b. Shall be constructed of high impact polystyrene for sizes 50 thru 390, plastic shall be factory standard on unit under 390.
 - c. Shall be constructed of aluminum non-yellowing for sizes 410 thru 1550, aluminum shall be factory standard on units over 410.
9. Provide External Electrical Access:
 - a. Shall eliminate removing the motor pack on installation.
10. Mounting Brackets:
 - a. Shall be adjustable for multiple installation conditions.
11. Options/Accessories:
 - a. Ceiling Radiation Damper:
 - 1) UL classified and shall be rated for three to four hours fire resistance.
 - 2) Shall be mounted directly beneath the fan.
 - 3) Shall adhere National Fire Protection Association (NFPA), Standard 90A, which requires the opening in fire rated ceiling/floors to be protected by rated CRD's.
 - b. Disconnect Switches:
 - 1) Disconnect shall be: <<select one of the following, consult rep. for exact type applicable to your project.>>:
 - a) NEMA 1: indoor application no water: factory standard
 - c. Wall Discharge:
 - 1) Type: Square/Rectangular Connection, hooded wall cap model WC.

2.3 CENTRIFUGAL SQUARE INLINE CABINET FANS

A. Direct Driven Backward Inclined Inline Fans:

1. Manufacturer:
 - a. Fans shall meet model numbers, types, sizes, capacities, and electrical characteristics as indicated on the contract drawings. Acceptable manufacturers: Greenheck, Cook, Penn Ventilator or Twin City Blower Company.
2. General:
 - a. Shall have a normal operating temperature of up to 130 Fahrenheit (54.4 Celsius).
 - b. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.
3. Wheel:
 - a. Shall be non-overloading, backward inclined centrifugal wheel.
 - b. Shall be constructed of aluminum.
 - c. Shall be statically and dynamically balanced in accordance to AMCA Standard 204-05.
 - d. The wheel cone and fan inlet shall be matched and shall have precise running tolerances for maximum performance and operating efficiency.
 - e. Single thickness blades shall be securely riveted or welded to a heavy gauge back plate and wheel cone.
4. Motors:
 - a. Motor enclosures shall be Open driproof

- b. Motors shall be permanently lubricated, sleeve bearing type on sizes 8-12 and ball bearing type on sizes 14-24 to match with the fan load and furnished at the specific voltage and phase.
- c. Motor shall be accessible for maintenance.
- 5. Housing/Cabinet Construction:
 - a. Construction material: Galvanized
 - b. Square design constructed shall be of heavy gauge galvanized steel and shall include square duct mounting collars.
 - c. Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.
- 6. Housing Supports and Drive Frame:
 - a. Housing supports shall be constructed of structural steel with formed flanges.
 - b. Drive frame shall be welded steel which supports the motor.
- 7. Disconnect Switches:
 - 1) NEMA 1: indoor application no water: factory standard
- 8. Duct Collars:
 - a. Shall be of square design to provide a large discharge area.
- 9. Access Panel:
 - a. Provide two sided access panels, to allow access to all internal components.
 - b. Locate perpendicular to the motor mounting panel.

B. Belt Drive Duct Inline Centrifugal Fans:

- 1. Manufacturer:
 - a. Fans shall meet model numbers, types, sizes, capacities, and electrical characteristics as indicated on the contract drawings. Acceptable manufacturers: Greenheck, Cook, Penn Ventilator or Twin City Blower Company.
- 2. General:
 - a. Fans shall have a maximum continuous operating temperature of 130 Fahrenheit (54.4 Celsius).
 - b. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.
- 3. Wheel:
 - a. Shall be forward curved centrifugal wheel.
 - b. Shall be constructed of galvanized steel.
 - c. Shall be statically and dynamically balanced in accordance with AMCA Standard 204-05.
- 4. Motors:
 - a. Motor enclosures: Open dripproof
 - b. Motors shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
 - c. Motor shall be mounted on vibration isolators, out of the airstream.
 - d. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.
 - e. Motor shall be accessible for maintenance.
- 5. Shafts and Bearings:
 - a. Fan shaft shall be ground and polished solid steel with an anti corrosive coating.
 - b. Shall be permanently sealed bearings or pillow block ball bearings.
 - c. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.

- d. Bearings shall be 100 percent factory tested.
 - e. Fan Shaft first critical speed shall be at least 25 percent over maximum operating speed.
6. Housing:
- a. Shall be constructed of heavy gauge galvanized steel.
 - b. Shall be of rectangular design construction and shall include rectangular duct mounting collars.
 - c. Shall include prepunched mounting brackets.
7. Housing Supports and Drive Frame:
- a. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
 - b. Shall be designed with belt adjustment to eliminate scroll damage.
8. Duct Collars:
- a. Shall be provided for duct connections for outlet and inlet collars.
9. Drive Assembly:
- a. Belts, pulleys, and keys shall be oversized for a minimum of 150 percent of driven horsepower.
 - b. Belts shall be static free and oil resistant.
 - c. Pulleys shall be: Cast type, keyed, and securely attached to wheel and motor shafts.
 - d. Motor pulleys shall be adjustable for final system balancing.
 - e. Readily accessible for maintenance.
10. Access Panel:
- a. Provide removable access panel for access to all internal components.
11. Mounting Brackets:
- a. Provide fully adjustable mounting brackets for multiple installation conditions.
12. Options/Accessories:
- a. Disconnect Switches:
 - a) NEMA 1: indoor application no water: factory standard

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed and dimensions are as shown on the shop drawings and instructed by the fan manufacturer.

3.2 PREPARATION

- A. Coordinate roof curb installation with the Division 07 specifications.
- B. Ensure that roof openings are square and/or round and accurately aligned, correctly located, and in tolerance.
- C. Ensure that ducts are plumb, sized correctly, and to proper elevation above roof decks.

3.3 INSTALLATION

- A. Secure roof, and wall fans and gravity ventilators with cadmium plated steel lag screws to roof curb.
- B. Suspended Cabinet Fans: Install flexible connections between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.

- C. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.
- D. Install safety screen where inlet or outlet is exposed.
- E. Pipe scroll drains to nearest floor drain.
- F. Install backdraft dampers on the discharges of exhaust fans when they are not integral with fans and as indicated on the Contract Drawings.
- G. Provide adjustable sheaves as required for final air balance.
- H. Install Work in accordance with all applicable codes, standards, and local authorities having jurisdiction requirements.
- I. Install fans in accordance with the fan manufacturer's instructions and as indicated on the contract drawings.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.5 CLEANING

- A. Vacuum clean coils and inside of fan cabinet.

3.6 DEMONSTRATION

- A. Demonstrate fan operation and maintenance procedures.

3.7 PROTECTION OF FINISHED WORK

- A. Refer to Division 01 Section 01700 - "Execution Requirements": Requirements for protecting finished Work.
- B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and each fan has been test run under observation.

3.8 ADJUSTING

- A. Adjust fans to function properly.
- B. Adjust belt tension on belt driven fans.
- C. Lubricate bearing.
- D. Adjust drives for final system balancing.
- E. Check wheel overlap.

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. Louver face diffusers.
2. Linear bar diffusers.
3. Linear slot diffusers.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Louver Face Diffuser:

1. Material: Steel or Aluminum.
2. Finish: Baked enamel, color selected by Architect.
3. Face Size: As per schedule
4. Mounting: See architectural plans for ceiling types.
5. Pattern: One-way, Two-way, Two-way, corner Three-way Four-way, Adjustable core style.
6. Dampers: Radial opposed blade, Butterfly, Combination damper and grid.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Bar Diffuser:

1. Material: Steel or Aluminum.
2. Finish: Baked enamel, color selected by Architect.
3. Narrow Core Spacing Arrangement: 1/8-inch- thick blades spaced 1/4 inch apart, zero or 15-degree deflection.
4. Wide Core Spacing Arrangement: 1/8-inch- thick blades spaced 1/2 inch apart, zero or 15-degree deflection.
5. Wide Core Spacing Arrangement: 3/16-inch- thick blades spaced 1/2 inch apart, zero or 15 degree deflection.
6. Pencil-Proof Core Spacing Arrangement: 3/16-inch- thick blades spaced 7/16 inch apart, zero or 15-degree deflection.

7. Two-Way Deflection Vanes: Extruded construction fixed louvers with removable core.
 8. Frame: 1-1/4 inches 1 inch 3/4 inch 1/2 inch 3/16 inch wide.
 9. Mounting Frame: .
 10. Mounting: Concealed bracket.
 11. Damper Type: Adjustable opposed-blade assembly.
 12. Accessories: Plaster frame Directional vanes Alignment pins Core clips Blank-off strips.
- B. Linear Slot Diffuser:
1. Material - Shell: Aluminum,.
 2. Material - Pattern Controller and Tees: Aluminum.
 3. Finish - Face and Shell: Baked enamel, black.
 4. Finish - Pattern Controller: Baked enamel, black.
 5. Finish - Tees: Baked enamel, color selected by Architect.
 6. Slot Width: 1 inch.
 7. Number of Slots: Four.
 8. Length: 48 inches.
 9. Accessories: Plaster frame T-bar slot Center notch T-bar on inlet side T-bar on both sides T-bar clip on one side T-bar clips on both sides. Verify with Architect.

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.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 7413

PACKAGED ROOFTOP 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. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Gas furnace.
 - 3. Economizer outdoor- and return-air damper section.
 - 4. Integral, space temperature controls.
 - 5. Roof curbs.
- B. Related Sections include the following:
 - 1. Section 237333 "Indoor Indirect-Fuel-Fired Heating and Ventilating Units" for outdoor units providing 100 percent tempered outdoor air with heat exchangers.
 - 2. Section 237339 "Indoor, Direct Gas-Fired Heating and Ventilating Units" for outdoor units providing 100 percent tempered outdoor air without heat exchangers.
 - 3. Section 237433 "Dedicated Outdoor-Air Units" for outdoor equipment air conditioning 100 percent outdoor air to replace air exhausted from a building.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- D. 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.
- E. 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: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
 - 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - 3. Wind-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.5 INFORMATIONAL SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.7 MATERIALS MAINTENANCE 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.
 - 1. Fan Belts: One set for each belt-driven fan.
 - 2. Filters: One set of filters for each unit.

1.8 QUALITY ASSURANCE

- A. ARI Compliance:
 - 1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to 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 five years from date of Substantial Completion.
 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 MANUFACTURERS

- 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. Carrier Corporation.
 2. Trane; American Standard Companies, Inc.
 3. YORK International Corporation.

2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 1. Exterior Casing Thickness: [0.0626 inch thick.
- C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.028 inch thick[, perforated 40 percent free area
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
1. Materials: ASTM C 1071, Type I.
 2. Thickness: 1 inch
 3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
 4. Liner Adhesive: Comply with ASTM C 916, Type I.
- E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep.
1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 2. Drain Connections: Threaded nipple.
 3. Pan-Top Surface Coating: Corrosion-resistant compound.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

- A. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- C. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 COILS

- A. Supply-Air Refrigerant Coil:
 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 2. Coil Split: Interlaced.
 3. Baked phenolic coating.
 4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections.
- B. Outdoor-Air Refrigerant Coil:
 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 2. Baked phenolic coating.

2.5 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor: [Hermetic, reciprocating] [Semihermetic, reciprocating] [Hermetic, scroll], mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief[, and crankcase heater].
- B. Refrigeration Specialties:
 - 1. Refrigerant: R-407C or 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.
 - 7. Automatic-reset compressor motor thermal overload.
 - 8. Brass service valves installed in compressor suction and liquid lines.
 - 9. Hot-gas bypass solenoid valve with a replaceable magnetic coil.

2.6 AIR FILTRATION

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated: Minimum 90 percent arrestance, and MERV 8.

2.7 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
 - 1. Fuel: Natural gas.
 - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
 - 3. High-Altitude Kit: For Project elevations more than 2000 feet above sea level.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Venting: Gravity vented.
- E. Safety Controls:
 - 1. Gas Control Valve: Single stage
 - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

- A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 CONTROLS

A. Basic Unit Controls:

1. Control-voltage transformer.
2. Wall-mounted thermostat or sensor with the following features:
 - a. Automatic changeover.
 - b. Adjustable deadband.
 - c. Exposed set point.
 - d. Exposed indication.
3. Unit-Mounted Annunciator Panel for Each Unit:
 - a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
 - b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
 - c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

B. Electronic Controller:

1. 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. Firestats: Stop fan and close outdoor-air damper if air greater than [130 deg F (54 deg C)] enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
 - c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Section 283111 "Digital, Addressable Fire-Alarm System" and Section 283112 "Zoned (DC Loop) Fire-Alarm System."
2. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of four programmable periods per day.
3. Unoccupied Period:
 - a. Heating Setback: 10 deg F (5.6 deg C)
 - b. Cooling Setback: System off.
 - c. Override Operation: Two hours.
4. Supply Fan Operation:
 - a. Occupied Periods: Run fan continuously.
 - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
5. Refrigerant Circuit Operation:
 - a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.

- b. Refrigerant coil may be cooling or heating with air-to-air heat pump. Retain second option in first subparagraph below for air-to-air heat pumps.
 - c. Unoccupied Periods: Compressors off.
 - 6. Gas Furnace Operation:
 - a. Occupied Periods: Cycle burner to maintain room temperature.
 - b. Unoccupied Periods: Cycle burner to maintain setback temperature.
 - 7. Economizer Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open to 15 percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F (15 deg C). Use outdoor-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.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
 - c. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 4 to 20 mA.

2.11 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- B. Hail guards of galvanized steel, painted to match casing.

2.12 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: 1-1/2 inches
 - 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 air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- B. Curb Height: 14 inches

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. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger than supported equipment and minimum 6 inches (150 mm) above finished ground elevation.
 - 2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 3. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 5. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."
- B. Equipment Mounting: Install RTUs on concrete base using elastomeric pads. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Minimum Deflection: 1 inch (25 mm).
- C. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "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. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to RTUs to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Section 231123 "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.
- C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the 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 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. Install normal-weight, 3000-psi (20.7-MPa), compressive strength (28-day) concrete mix inside roof curb, 4 inches (100 mm) thick. Concrete, formwork, and reinforcement are specified with concrete.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- B. 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.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 1. Inspect for visible damage to unit casing.
 2. Inspect for visible damage to furnace combustion chamber.
 3. Inspect for visible damage to compressor, coils, and fans.
 4. Inspect internal insulation.
 5. Verify that labels are clearly visible.
 6. Verify that clearances have been provided for servicing.
 7. Verify that controls are connected and operable.
 8. Verify that filters are installed.
 9. Clean condenser coil and inspect for construction debris.
 10. Clean furnace flue and inspect for construction debris.
 11. Connect and purge gas line.
 12. Remove packing from vibration isolators.
 13. Inspect operation of barometric relief dampers.
 14. Verify lubrication on fan and motor bearings.
 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 16. Adjust fan belts to proper alignment and tension.
 17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.

18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) 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.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. 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.
27. 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.
28. 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.
29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 **CLEANING AND 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 site during other-than-normal occupancy hours for this purpose.
- B. 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. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

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 01 Specification Sections, apply to this and other sections of Electrical and Special Construction Divisions.

1.2 SUMMARY

- A. This section includes qualification requirements of the installer and suppliers, submittal procedures, record keeping, required testing and general electrical procedures.
- B. Section Includes:
 - 1. Additional submittal requirements.
 - 2. Installer and product requirements.
 - 3. Identification of equipment.
 - 4. Firestopping for electrical installations.
 - 5. Supporting devices for electrical components.
 - 6. Concrete equipment pads.
 - 7. Equipment bollards.
 - 8. Fuses.
 - 9. Equipment connections.
 - 10. Cutting and patching for electrical construction.
 - 11. Touch up painting.
 - 12. Project conditions.
 - 13. Additional warranties.
 - 14. Utility coordination.
- C. Related Sections:
 - 1. Section 26 12 00 "Medium Voltage Transformers" for concrete pad or bollard requirements.
 - 2. Section 16 32 00 "Packaged Generator Assemblies" for concrete pad and bollard requirements.
 - 3. Section 26 13 00 "Medium Voltage Switchgear" for concrete pad or bollard requirements.
 - 4. Section 26 20 00 "Low Voltage Electrical Distribution" for concrete pad or bollard requirements.
 - 5. Section 26 22 00 "Low Voltage Transformers" for concrete pad requirements.
 - 6. Section 26 29 00 "Low Voltage Controllers" for motor control center concrete pad requirements.
- D. Products installed but not supplied under this Section:
 - 1. Provide electrical connections and materials required for the installation of the following:
 - a. Countertops, Casework & Cabinets.
 - b. Modular office partitions and panels.
 - c. Elevators.
 - d. Fume hoods and/or BioSafety Cabinets.

- e. Exhaust hoods.
 - f. Lab equipment.
 - g. Manufacturing equipment.
 - h. Garage and/or shop equipment.
 - i. Kitchen and food service equipment.
 - j. Electrically operated doors, door strikes, maglocks, etc.
 - 2. Coordinate electrical connections with installation requirements and manufacturers' nameplates and written instructions.
 - 3. Verify equipment nameplates and connection requirements prior to rough in.
- E. Permits and Fees:
- 1. Apply, pay for and secure all permits, required by the Authorities Having Jurisdiction prior to start of work, in accordance with contract General Conditions and Division 01.
 - 2. Deliver all certificates to the Owner prior to final acceptance of work.
- F. Conflicts:
- 1. Where variances occur within drawings and/or specifications, procedures of the General Conditions shall be followed.
 - 2. In cases where clarification is not requested, provide the item or arrangement of better quality, greater value, or higher cost in the Contract Price.
 - 3. Bring to the Architect's attention, any field conflicts or existing conditions, which prevent the intended work as designed.

1.3 ACRONYMS

- A. The following acronyms are used throughout the Electrical Division specifications, defined as follows:
- 1. AASHTO American Association of State Highway and Transportation Officials
 - 2. ADA Amer. With Disabilities Act
 - 3. ANSI American National Standards Institute
 - 4. ASME American Society of Mechanical Engineers
 - 5. ASTM American Society for Testing and Materials
 - 6. IBC International Building Code
 - 7. IEEE Institute of Electrical and Electronics Engineers
 - 8. ETL Electrical Testing Laboratory
 - 9. FM Factory Mutual Research Corporation
 - 10. NEC National Electrical Code
 - 11. NECA National Electrical Contractors Association
 - 12. NEMA National Equipment Manufacturers Association
 - 13. NESC National Electrical Safety Code
 - 14. NETA National Electrical Testing Association
 - 15. NFPA National Fire Protection Association
 - 16. NLPI Lightning Protection Institute
 - 17. UL Underwriter's Laboratories

1.4 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term product includes the terms material, equipment, system, and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature, which is current as of date of the Contract Documents.
 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes proposed by Contractor in products, materials, equipment, and methods of construction required by the Contract Documents.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is the only named manufacturer or is the "first" named manufacturer, or is accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.
- D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
- E. Extended Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.5 SUBMITTALS

- A. General: Submit each item in this Section according to the conditions of the contract and Division 01 Specification Sections.
- B. General:
1. Material and Equipment List
 2. Shop Drawings
 3. Product Data
 4. Installation and Coordination Drawings
 5. Record Documents
 6. Operation and Maintenance Manuals
 7. Construction Phasing and Outage Schedule
- C. Basis-of-Design Comparable Products Submission:
1. Document each request with supporting data substantiating compliance of proposed product with Basis-of-Design product.
 2. Use the attached "Comparable Product Submittal Form" in addition to the requirements specified herein.
 3. Comparable products will not be reviewed without completion of the attached form.

- D. Product Substitutions: Comply with all requirements of Division 01.
- E. Comparable Products Submission:
1. Document each request for a proposed comparable product with supporting data substantiating compliance of proposed product with Basis-of-Design product.
 2. Use the attached "Comparable Product Submittal Form" in addition to the requirements specified herein.
 3. Comparable products will not be reviewed without completion of the attached form.
- F. Coordination of Submittals: Coordinate Electrical and Special Construction Division submittals with those of all other Divisions.
- G. Electrical Division additional submittal requirements: On projects where Div 01 does not specify otherwise, and where Owner does not have a defined submittal procedure, provide submittals, as follows:
1. Clearly identify all submittals, as follows:
 - a. Number each submittal starting with the specification section associated with the product(s). Each successive product from same spec section shall utilize a sequential suffix (i.e. -01, -02).
 - b. Following each number, include specific English name of each product. (i.e. 26 20 00-01 Panelboards).
 - c. Do not combine product data from different spec sections into a single submittal package as this may prevent approval of one product due to resubmission requirement of another.
 - d. Provide catalog spec and/or data sheets to completely describe proposed equipment. A product model number alone, with no supporting description or data will not be approved.
 - e. Where numerous model or product numbers appear, clearly indicate the exact type, model number, size, options, and special features of the proposed item.
 - f. Where different products are used in different locations, identify intended application, location, etc.
 - g. Factory order forms showing only required capacities, are not acceptable.
 - h. Identify all options furnished to meet specifications.
 - i. The Architect shall not select or mark equipment ratings and/or options. Submittals not properly and specifically marked shall be returned without review.
 2. Identify any discrepancies in the contract documents affecting submittals and seek clarification.
 3. Submittals shall explicitly identify any deviations from the drawings, specifications or design intent.
- H. Material and Equipment List:
1. Submit within 30 calendar days after the award of contract for preliminary review.
 2. List all proposed materials and equipment.
 3. Indicate proposed manufacturer(s).
 4. No further submittals will be reviewed until this list has been submitted and approved.
 5. Identify missing items and the reason for their absence.
- I. Product Data:

1. Manufacturer's specifications, data sheets.
 2. Catalog cuts.
 3. Dimensional drawings.
 4. Installation Instructions.
 5. Wiring & connection diagrams.
 6. Capacity ratings, performance curves.
 7. Information required indicating contract compliance.
 8. Clearly indicate the exact size or rating proposed.
- J. Shop Drawings:
1. All specially fabricated items.
 2. Modifications to standard items.
 3. Specially designed systems or products.
- K. Closeout Submittals: Submit in accordance with the General Conditions and Division 1 requirements.
1. Electrical Division Operation and Maintenance Manuals:
 - a. Arrange material in sections according to Electrical Division spec sections.
 - b. Include a cover sheet, which contains the name and phone number of the Installer, Distributor, Supplier, Local Service Company, etc. for each system or product group.
 - c. O & M Manuals shall also include the following:
 - d. Material and Equipment List.
 - e. Copies of all approved submittals.
 - f. Acceptance Test Reports (ground resistance, etc.)
 - g. Manufacturer's Product Warranties.
 - h. Factory data sheets, wiring diagrams, etc.
 - i. Spare parts lists.
 - j. All operation and instruction papers.
 - k. Maintenance schedules.
 2. Record Drawings:
 - a. During construction, maintain drawings on blue or black line white prints.
 - b. Record all changes and alterations in red ink.
 - c. Record the installed electric feeders, equipment, etc.
 - d. Actual installed locations of panels, switchboards, transformers, etc.
 - e. All feeders overhead, underslab or in chases.
 - f. Pullboxes, handholes and splice box locations.
 - g. All underground feeders, conduit, ducts, cables, handholes, manholes, etc. with installed dimensions from permanent construction elements.
 - h. All modifications, changes, deletions or additions made during construction.
 - i. Submit one (1) complete set of white prints with "as-built" information neatly recorded at project completions.
- L. Required Submittals: Submit the following items, as a minimum requirement for this project:
1. Section 26 05 00 Common Work Results for Electrical:
 - a. Copies of Electrical Inspection Reports
 - b. Equipment Acceptance Test Reports

- c. Completed Punchlist with contractors' initials/dates
- d. As-Built drawings
- e. O&M Manuals
- 2. Section 26 05 13 Medium Voltage Cables
 - a. Product data for MV cables
 - b. Product data for MV splice and/or termination kits
 - c. Post Installation acceptance testing report.
- 3. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables
 - a. Building wires and conductors.
 - b. Acceptance testing of conductors, feeders, etc.
- 4. Section 26 05 21 Heat Tracing System
 - a. Heat Tracing cables.
 - b. Splices and connectors.
 - c. Ground fault protection devices.
 - d. Thermostats.
- 5. Section 26 05 26 Grounding and Bonding for Electrical Systems
 - a. Ground rods
 - b. Ground buses
- 6. Section 26 05 33 Raceways and Boxes for Electrical Systems
 - a. Conduits.
 - b. Junction boxes.
 - c. Floor mounted devices.
- 7. Section 26 12 00 Medium Voltage Transformers
 - a. Product data for transformers and all accessories/components'
 - b. Elevation and plan view drawings.
 - c. 1-line diagram showing all internal/external components, connections, accessories, etc.
 - d. Post Installation acceptance testing report.
 - e. Post Installation Infrared scanning report.
- 8. Section 26 20 00 Low Voltage Electrical Distribution
 - a. Enclosed and automatic circuit breakers.
 - b. Elevator Main Line Disconnects.
 - c. Surge Protective Devices (SPD)
 - d. Safety Disconnect Switches.
 - e. Magnetic Contactors.
 - f. Panelboards.
 - g. Switchboards.
 - h. Post Installation acceptance testing reports.
 - i. Post Installation Infrared scanning reports.
- 9. Section 26 22 00 Low Voltage Transformers
 - a. Product data for transformers and all accessories/components
 - b. Elevation and plan drawings.
 - c. 1-line diagram showing all internal/external components, connections, accessories, etc.
 - d. Post Installation acceptance testing report.
 - e. Post Installation Infrared scanning report.
- 10. Section 26 27 26 Wiring Devices
 - a. A/C switches.
 - b. Receptacles.
 - c. Connectors.
 - d. Device plates and covers.
 - e. Pin/sleeve connectors.
- 11. Section 26 29 00 Low Voltage Controllers
 - a. Thermal manual motor starter switches.
 - b. Motor starters.
 - c. 600VAC motor control centers.

12. Section 26 32 00 Packaged Generator Assemblies
 - a. Product data for Engine-generator assembly and all accessories
 - b. Post installation startup test report.
 - c. Post Installation Load Test report.
13. Section 26 36 00 Transfer Switches
 - a. Product Data for transfer switches, accessories and components
14. Section 26 41 00 Lightning Protection
 - a. Product Data for lighting protection equipment.
15. Section 26 43 13 Surge Protective Devices (TVSS)
 - a. Product Data for surge protective device equipment.
16. Section 26 50 00 Lighting
 - a. Product data for all Individual lighting fixtures.
 - b. Low voltage contactor panels.
 - c. Occupancy sensors.
 - d. Light poles.
 - e. FC calculations as requested
 - f. Wiring diagrams for lighting controls, etc.
17. Section 26 50 01 Lighting Control Panelboards
 - a. Product data for all lighting control panelboards and accessories.
 - b. Wiring diagrams for lighting control systems.
18. Section 27 10 00 Structured Cabling
 - a. Product data for all outlets, cabling, cross connects, patch panels.
 - b. Fiber optic cables & terminations and components.
 - c. Equipment racks, wire management devices.
 - d. Cable labeling scheme.
 - e. Post-installation testing & documentation
19. Section 28 13 00 Proximity Reader Door Controller:
 - a. Bill of materials.
 - b. Manufacturer's product data on all proposed equipment.
 - c. Sequence of operation for all modes:
 - d. Riser diagrams showing all devices and wiring types.
 - e. Details/drawing of system configuration.
20. Section 28 23 01 Interconnected Intercom & CCTV system
 - a. Bill of materials showing quantities and model numbers.
 - b. Manufacturer's product data on all proposed equipment.
 - c. System wiring schematic.
 - d. Written sequence of operation for various components:
 - e. Video control and/or recording equipment.
 - f. Drawing of proposed racks, enclosures, supports, etc.
21. Section 28 31 00 Fire Detection and Alarm System
 - a. Bill of materials showing quantities and model numbers.
 - b. Manufacturer's product data on all proposed equipment.
 - c. System wiring schematic.
 - d. List of all system program points with device ID.
 - e. Device schedule matrix
 - f. Written sequence of operation for all modes
 - g. Graphic Annunciator Panel drawing
 - h. Scaled Floor Plans
 - i. Calculations for Battery power and Voltage drop
 - j. Copy of AHJ Final Inspection / Approval

1.6 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms “Listed and Labeled”: As defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.
- B. Underwriter’s Laboratory (UL) Requirements: All equipment containing electrical components and provided under Division 26, 27 and 28 shall bear the Underwriter’s Laboratory (UL) label, as a complete packaged system.
- C. Field Certifications and Labeling:
1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a listed label at the installer’s expense.
 - a. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.
 - b. Provide services of a UL recognized, independent Electrical Testing Laboratory (ETL) to provide field inspection and testing. Provide an ETL Label on all such equipment as proof of satisfactory inspection.
- D. Fire Safe Materials: Unless otherwise indicated, materials shall conform to UL, National Fire Protection Agency (NFPA) or American Society for Testing and Materials (ASTM) standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.
- E. Install all components and equipment per manufacturer’s written instructions.
- F. Installer Qualifications:
1. Provide proof of qualification. Submit the following, when requested:
 - a. Five (5) comparable completed projects.
 - b. Reference letters from minimum of three (3) registered professional engineers, general contractors, or building owners, explaining proficiency, quality of work, or other attribute on projects of similar size or substance.
 - c. Copy of Master Electrician's License.
 - d. Local or State license.
 - e. BICSI RCDD certification, as required in other Electrical Division sections.
 - f. NICET certification, as required in other Electrical Division sections.
 2. Electrical installer shall utilize a full time project foreman in charge of all electrical work.
 - a. Fully qualified and experienced in such work.
 - b. Available, on site, at all times during construction.
 - c. All communication shall be through this person.
 3. Installer of specialized systems such as Fire Alarms, telecommunication systems, etc. shall meet the requirements of the associated spec section(s).
- G. Installation Quality: In accordance with listed Codes, recognized trade organizations and standards.
1. ADA Americans with Disabilities Act Accessibility Guidelines
 2. ANSI/EIA/TIA American National Standards Institute
 3. ASME American Society of Mechanical Engineers
 4. IEEE C2 “National Electrical Safety Code”
 5. NEMA National Equipment Manufacturers Association
 6. NECA National Electrical Contractors Association “Standards of

- | | | |
|----|------|--|
| | | Installation” |
| 7. | NEMA | National Electrical Manufacturer’s Association |
| 8. | NETA | National Electrical Testing Association |
| 9. | UL | Underwriter’s Laboratories |

H. Comply with the latest version of following Codes, Standards and regulations as adopted by the Authority Having Jurisdiction, unless otherwise specified.

1. NFPA
2. NFPA 70 “National Electrical Code”.
3. IBC
4. Local Amendments to the above Codes

1.7 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Arrange for proper shipping methods for all materials.
2. Provide for handling and unloading of all materials at site or at offsite storage facility.
3. Provide for proper transportation between offsite storage and project site.
4. Provide rigging and other handling services, when necessary.

B. Storage and Protection:

1. Store all materials in dry, heated areas, unless manufacturers permit other storage environments.
2. Store equipment according to manufacturers’ written instructions.
3. Protect materials subject to damage or corrosion from excessive moisture.
4. Protect equipment subject to damage from excessive heat or sunlight in ventilated environments.
5. Protect equipment from dripping, splashing or sprayed materials.

C. Repair and Replacement of Damaged Equipment: Repair equipment damaged as a result of improper storage or handling at no expense to Owner. If, in the opinion of the Architect, equipment cannot operate properly after repairs are made, replace at no cost to Owner.

1.8 PROJECT CONDITIONS

A. Occupied Building: Allowances shall be considered and included in bids for performing work within existing, occupied buildings. Certain functions, i.e. core drilling, may be limited in their allowed times, due to disturbance of other occupants. Work occurring within occupied areas may require scheduling of work during unoccupied periods.

1.9 SEQUENCING

A. General Sequencing:

1. Coordinate electrical work with other trades based on phasing and sequence of construction, as identified elsewhere in the contract documents.
2. Provide all scheduling, phased installation, etc. to coordinate with overall phasing plans.

B. Electrical Division Sequencing, Coordination, and Integration:

1. Coordinate systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.
4. Coordinate the installation of required supporting devices, sleeves and conduit to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Make provisions for large equipment requiring positioning prior to closing in the building.
6. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
7. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
8. Coordinate requirements for access panels and doors where electrical items requiring access are concealed behind finished surfaces.

1.10 COMMISSIONING

- A. Provide post-installation commissioning for particular products and systems, as specified within individual specification sections.

1.11 WARRANTY

- A. Provide warranty in accordance with the General Conditions and Division 01 requirements, and as stated herein.
- B. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- C. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
 1. Manufacturer's Standard Form: Modified to include project-specific information and properly executed.
 2. Refer to Divisions 02 through 28 Sections for specific content requirements and particular requirements for submitting special warranties.
- D. Special Warranties: Provide additional product and/or installation warranties for particular products, as specified within individual specification sections.
- E. Obtain all warranty papers and records from the Original Equipment Manufacturer (OEM) according to their warranty policy and deliver the same to the Owner. Fulfill all the OEM's requirements to validate the warranty at conclusion of project. Include copies of warranty papers with Closeout Submittals.

1.12 MAINTENANCE

- A. Extra Materials: Provide extra, loose and/or spare materials, as required by individual specification sections.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

- A. General Product Requirements: Provide products that comply with Contract Documents, which are undamaged and new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for complete installation and intended use and effect.
 - 2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Where products are accompanied by the term as selected, Architect will make selection.
 - 4. Where products are accompanied by the term match sample, sample to be matched is Architect's.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. General Compliance Requirements: Compliance requirements for individual products, as indicated in Contract Documents, are multiple in nature and may include generic descriptions, performance requirements, compliance with reference standards, conformance with graphic details and other similar forms and methods of indicating requirements, all of which must be complied with.
- C. Procedures for Selecting Products: Contractor's options for selecting products are limited by Contract Document requirements, and are not controlled by industry traditions or procedures experienced by Contractor on previous construction projects.
- D. Products specified by Reference Standards, Codes and Regulations: Select from among products, which can be shown to comply with referenced documents.
- E. Products specified by Naming Products and Manufacturers: Select from among products listed.
- F. Products specified by Naming One Manufacturer's Product as the Basis-of-Design with Reference to Other Manufacturers: Select either the specified Basis-of-Design product or an approved comparable product by one of the other named manufacturers.
 - 1. Comply with provisions in Comparable Products Article to obtain approval for use of a comparable product by one of the named manufacturers.
- G. Products specified by Naming One Manufacturer's Product and Indicating Option of Selecting Comparable Products by stating or Approved Equivalent or similar language: Select either the specified product or an approved comparable product.
 - 1. Comply with provisions in Comparable Products Article to obtain approval for use of an unnamed comparable product by another manufacturer.
- H. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether proposed product matches satisfactorily.
- I. Visual Selection Specification: Where Specifications include the phrase as selected from manufacturer's standard colors, patterns, textures or similar phrase, select a product that complies with other specified requirements. Architect will select color, pattern, and

texture.

1. Standard Range: Where Specifications include the phrase standard range of colors, patterns, textures or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that does not include premium items.
2. Full Range: Where Specifications include the phrase full range of colors, patterns, textures or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Where Basis-of-Design products are specified by name, submit the following, in addition to other required submittals, to obtain approval of a comparable product by one of the named manufacturers:
1. Evidence that the proposed comparable product does not require revisions to the Contract Documents, and is consistent with the Contract Documents.
 2. Documentation that the proposed comparable product will produce the indicated results, and is compatible with other portions of the Work.
 3. Detailed comparison of significant qualities of proposed product with the Basis-of-Design product in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, serviceability, visual effect, and specific features and requirements indicated.
 4. Evidence that proposed product provides specified warranty.
 5. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 6. Samples, if requested.

2.3 IDENTIFICATION PLATES

- A. General:
1. Dimensions: Minimum of 1" H x 2 1/2" W.
 2. Lettering: All capitals, 1/4"H x 1/16" stroke. Indicate circuit number, device (EXHAUST FAN 1, PUMP No. 2, etc.).
 3. Indoor Tags:
 - a. Laminated phenolic plastic.
 - b. White with black engraved letters.
 - c. Stainless steel attaching screws.
 4. Outdoor Tags:
 - a. Stainless steel tag.
 - b. Stainless steel attaching screws.
 5. Manhole/Handhole Cable Tags:
 - a. Stainless steel tag.
 - b. Nylon cable ties.

2.4 LOW VOLTAGE TERMINAL IDENTIFICATION

- A. Permanent identification in accordance with the manufacturer's shop drawings or product data.
- B. Identify all control cables and wires:
1. All indoor locations:
 - a. Nylon, self-adhesive.
 - b. Factory printed with permanent numerals/letters on white background.

2. LEM Wire Markers, or equal.

2.5 WARNING SIGNS

- A. Warning signs to identify "HIGH VOLTAGE - KEEP OUT".
- B. Interior Warning and Caution Signs:
 1. Preprinted, aluminum, baked-enamel finish signs.
 2. Punched for fasteners, with colors, legend, and size appropriate to the application.
- C. Exterior Warning and Caution Signs:
 1. Weather-resistant, nonfading, preprinted, cellulose acetate butyrate signs.
 2. 0.0396-inch (1-mm), galvanized steel backing.
 3. Colors, legend, and size appropriate to the application.
 4. 1/4-inch (6.4-mm) grommets in corners for mounting.

2.6 FIRE STOPPING MATERIALS

- A. General:
 1. UL 1479 Listed, Fire Tests for Through-Penetration
- B. For large openings:
 1. 2-part, RTV silicone elastomer expanding foam.
 2. 3-4X expansion.
 3. STI Pensil Series PEN Foam, Dow Corning Fire Stop Foam, or equal.
- C. For small openings and voids (less than 1"):
 1. 1-part, Intumescent sealant.
 2. Permanent, flexible and resilient.
 3. 5X free expansion.
 4. Red color for instant identification as fire barrier.
 5. 4-hour fire rating.
 6. STI Spec Seal Intumescent Sealant, 3M Fire Barrier Sealant, or equal.
- D. For openings around cable tray penetrations:
 1. Intumescent pillows.
 2. Compressible, lightweight, removable.
 3. Sealed poly bags.
 4. 1/2" expansion in all directions.
 5. STI Spec Seal SSB Pillows, or equal.

2.7 LOW VOLTAGE FUSES (0 - 600 VOLTS)

- A. UL 248, "Low Voltage Fuses" Listed, 250 or 600 volt, ratings per drawings or protected equipment manufacturer's nameplate.
- B. Class RK-1:

1. Current limiting, dual element, time delay.
2. Interrupting rating of 200,000 amps rms symmetrical.
3. Class R rejection clips.
4. Buss Low Peak LPS-RK (600 V) or LPN-RK (250 V), Littelfuse LLSRK (600 V) LLNRK (250 V).

C. Blown Fuse Indication:

1. For all fuses 100A and larger.
2. Automatic indication of blown (open) fuse.
3. Viewing window or indicating light.
4. Buss SAMI fuse covers or Littelfuse Indicator.

2.8 SUPPORTING DEVICES

A. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.

1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.
2. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel, except as otherwise indicated.

B. Steel channel supports have 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Fittings and accessories mate and match with channels and are from the same manufacturer.

C. 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.

D. Sheet-Metal Sleeves: 0.0276-inch or heavier galvanized sheet steel, round tube, closed with welded longitudinal joint.

E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

F. Expansion Anchors: Carbon-steel wedge or sleeve type.

G. Toggle Bolts: All-steel springhead type.

H. Powder-Driven Threaded Studs: Heat-treated steel.

2.9 CONCRETE EQUIPMENT PADS

A. Materials:

1. Interior Pads: 3000 PSI concrete at 28 days.
2. Exterior Pads: 3500 PSI concrete at 28 days; air entrained mix.
3. Steel mesh or rebar reinforcing, where required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions:

1. Examine site and existing conditions prior to submitting bids.
2. Carefully examine proposed locations where work will occur in existing buildings and excavation near existing piping, conduit, cable, structures, etc.
3. Make required allowances for the conditions.
4. Request clarifications and or directions in writing, if required.
5. No allowance will be made for any errors, oversights or other negligence on the part of the Installer.

3.2 PREPARATION

A. Protection:

1. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
2. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

B. Construction Power:

1. Obtain and pay for temporary electrical service for construction power, trailers, etc.
2. Provide all underground and/or overhead equipment, transformers, overcurrent devices, wires, connections, etc. for obtaining power from utility company or Owner's electrical lines.
3. Pay all charges for connections, accounts, metering and consumption charges for construction power.

C. Interface With Site Utility Companies:

1. Contact utility companies prior to any excavation or underground work.
2. Contact serving utility companies immediately upon award of contract. Do not install related equipment until fully coordinated with appropriate utilities.
3. Provide all construction schedules, dates of requested services, outage windows, equipment locations, etc. necessary for utility work.
4. Contractor shall contact each serving utility company to schedule the performance of work by utility company when site conditions are ready (including raceways, handholes/manholes, backboards, etc. installed by contractors).
5. Electric Utility:
 - a. Coordinate service entrance equipment and layout with power company prior to ordering or installing any service entrance equipment.
 - b. Furnish and install all incoming raceway, metering cabinets and meter sockets.
 - c. Coordinate cable, conduit, lug and C/T cabinet sizes for proper interface between utility owned/installed equipment and contractor-installed equipment.
 - d. Provide concrete pad for utility company's transformer as required by Utility.
6. Telephone Utility:
 - a. Coordinate raceways with telephone utility company.
7. Cable television Utility:
 - a. Coordinate raceways with cable television utility company.

- D. Utility Outages:
1. Schedule, stage, and perform all work such that interruptions to existing utilities and services are kept to a minimum.
 2. No outages shall occur without prior written notification of Owner and/or User.
 3. All required outages should be approved by the owner for optimum time scheduling.
 4. Written notice of not less than 15 calendar days shall precede all power outages.

3.3 INSTALLATION

- A. General Requirements:
1. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.
 2. Install work, generally as shown. Carefully examine all contract drawings and fit the work in each location without substantial alteration. Where departures are proposed or required, submit detailed drawings for acceptance.
 3. Installation shall provide the maximum possible headroom where mounting heights or other location criteria are not indicated.
 4. Install all items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.
 5. Install equipment with proper service and access clearances as required by NEC and manufacturers' requirements.
 6. Install such that future service or replacement shall not require interference with or removal of other installations.
 7. Provide access to all equipment, splice boxes, switches, controls and other devices, without use of poles, ladders, scaffolding, etc.
 8. Where equipment requiring access or service is concealed behind finished surfaces, provide access panel(s) or door(s).
- B. Miscellaneous Supports: Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices except where components are mounted directly to structural features of adequate strength.
- C. Sleeves: Install for cable and raceway penetrations of concrete slabs and walls, except where core-drilled holes are used. Install 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.
- D. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:
1. Fasten by means of wood screws or screw-type nails on wood; toggle bolts on hollow concrete masonry units; concrete inserts or expansion bolts on concrete or solid masonry; and by machine screws, welded threaded studs, or spring-tension clamps on steel.
 2. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts, machine screws, or wood screws.
 3. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or any other items.
 4. In partitions of light steel construction use sheet-metal screws.
 5. Drill holes in concrete beams so holes more than 1-1/2 inches (38 mm) deep do not cut main reinforcing bars.

6. Drill holes in concrete so holes more than 3/4 inch (19 mm) deep do not cut main reinforcing bars.
 7. Fill and seal holes drilled in concrete and not used.
 8. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.
- E. Rough-in:
1. Contract drawings are generally diagrammatic.
 2. Provide all offsets, bends, fittings and accessories, required to fit the work to the conditions, even though not specifically shown.
 3. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
 4. Refer to equipment specifications in all other Divisions for rough-in requirements.
 5. The Owner, and/or his/her representative, reserves the right to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.
- F. Cutting and Patching: Provide all cutting and patching in accordance with Division 1 and per the following requirements.
1. Perform all required cutting, fitting, and patching necessary for installation of Electrical Division work.
 2. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical systems and equipment as indicated on the drawings and specifications and other electrical items made obsolete by the new Work.

3.4 CONCRETE EQUIPMENT PAD INSTALLATION

- A. Interior Equipment Pads: Install concrete equipment (housekeeping) pads and bases for all transformers, switchgear, motor control centers, or other free-standing equipment.
- B. Exterior Equipment Pads: Install concrete pads with foundations for all on-grade transformers, switchgear, generators, control cabinets and other equipment.
- C. Interior Pad Installation:
1. Steel dowel rods and bonding agent for anchoring to existing slabs.
 2. 2" wider than equipment in all directions.
 3. 1" x 45° chamfer on all sides.
- D. Exterior Pad Installation:
1. 4" wider than equipment in all directions.
 2. 1" x 45° chamfer on all sides.
 3. Reinforce with steel mesh or rebar.
 4. Provide minimum 30" deep (below grade) foundation on all sides.
 5. Pour footings against undisturbed or compacted earth. Extend footings below the frost line for the location where installed.
 6. Turn down rebar or mesh into all foundation walls.
 7. Lowest side minimum of 6" above final grade.
 8. Install vapor barrier between earth and concrete.
 9. Provide PVC sleeves for all cables, conductors, grounding, etc. to penetrate pad.

3.5 CONSTRUCTION

A. Connections to Existing Work:

1. Keep all existing systems in operation during the progress of the work.
2. Provide temporary connections, where necessary to maintain continuous operation until the new systems and equipment are ready for operation.
3. Provide all necessary alterations, cuttings, fitting, etc. of existing work to make satisfactory connections between the new and existing work.
4. Leave the complete work in a finished and workmanlike condition.
5. Relocate existing equipment, conduits, wiring, etc. required. Make changes to existing work as may be required.

B. Interface with Other Work:

1. Mechanical and Plumbing Division Equipment and Systems:
 - a. Provide the following for equipment furnished and/or installed under mechanical/plumbing Divisions, unless specifically noted otherwise:
 - b. Line voltage power wiring connections to equipment such as motors, AHU's, heaters, etc.
 - c. Disconnect means per NEC.
 - d. Manual or automatic starting contactors, starters, switches, etc.
 - e. Furnish duct smoke detectors and sampling tubes. Install detectors into bases, and make all wiring connections (mechanical Division to install sampling tubes into ductwork).
 - f. Provide power to all motor operated smoke dampers, furnished and installed under other Divisions. Coordinate control operation through fire alarm duct detectors, per Section "Fire Detection and Alarm".
 - g. Furnish gas/oil burner emergency shutdown switches at boiler room exits per NFPA. Provide all wiring to gas or oil fired boilers and/or water heaters for manual shutdown. Final connections to equipment or associated control panels shall be by mechanical Division.
 - h. Mounting and connection of starters, speed controls, variable frequency drives and other such equipment furnished by mechanical Division.
 - i. Low voltage wiring between transformers and plumbing fixtures (faucets, toilets, urinals, etc.) for automatic controls, or line voltage wiring to fixtures, as required by equipment furnished under mechanical Divisions.
 - j. Mounting, connections and disconnects for power factor correction capacitors furnished with motors by mechanical Division.
2. All electrical work performed under mechanical and/or plumbing Divisions shall be provided in accordance with Division 26.
 - a. Work performed/provided by mechanical Division shall include the following, unless specifically noted otherwise:
 - b. All low voltage and line voltage control wiring including conduits, wiring, branch circuit breakers, etc.
 - c. EMS or ATC system wiring and connections.
 - d. Line voltage connections to all motor operated dampers, automatic valves, etc.
 - e. Line voltage thermostats and associated wiring.
 - f. All relays, contacts and other control equipment required for operation of mechanical Division equipment.
 - g. Fuses within equipment, switches, control panels, etc. furnished from the factory with the equipment.
 - h. Installation of duct smoke detector sampling tubes. Tubes furnished under Section "Fire Detection and Alarm".
3. It is the intent to provide a complete and operational system. The work between

mechanical and electrical Divisions is complementary and is meant to produce a single and operating system. Contractor shall make its own determination as to the distribution of responsibility among the various trades.

4. Equipment specified in other Divisions:
 - a. Provide the following for equipment furnished and/or installed under Divisions, unless specifically noted otherwise:
 - b. Power wiring to all fume, grease and/or exhaust hoods.
 - c. Field installation and wiring of equipment furnished loose with grease extraction and/or fume hoods:
 - 1) Lights
 - 2) Receptacles
 - 3) Toggle switches
 - 4) Associated backboxes
 - d. Hardwired connections to kitchen equipment.
 - e. Hardwired connections to elevators and associated equipment.

C. Routing of Electrical Feeds to Roof Mounted Equipment:

1. Conduit routing to roof mounted equipment shall be made so as to minimize the amount of conduit exposed above the roof.
2. Route conduit from building interior within roof curbs, where possible.
3. For condensing units and similar equipment, route conduit with refrigerant lines, using common penetrations through roof, coordinated with piping.
4. Where conduit must be run horizontally on roof surface, follow other piping, refrigerant lines, etc. Provide blocking, etc. to support conduit at regular intervals, per NEC. Secure conduit to blocks, supports, etc. to prevent movement.

D. Penetration of Waterproof Construction:

1. Minimize penetration of roofs, exterior walls and interior waterproof construction.
2. Provide necessary curbs, sleeves, shields, flashing, fittings and caulking to make the penetrations watertight.
3. All penetrations shall comply with roof manufacturer's recommended materials and methods.

E. Penetration of Fire Rated Construction:

1. Seal all in and around conduits and other electrical materials penetrating or creating openings in fire-rated, fire resistant or fire-stopped walls, ceilings, partitions and floors.

3.6 RE-INSTALLATION

- A. Where equipment is to be removed, and relocated or re-installed, provide careful removal of all items.
- B. Temporarily store all materials and equipment, which are to be re-installed. Protect from damage. Replace any items damaged during removal, storage or re-installation.
- C. Notify Owner immediately of any damaged or non-functioning equipment prior to removal or disconnecting. Document in writing or with photographs. Replace any damaged items for which Owner was not notified, at no cost to Owner.

3.7 REPAIR/RESTORATION

- A. Restore all finishes, equipment and surfaces to original condition, where affected by the work. Provide the following, as applicable:
1. Replace damaged ceiling tiles.
 2. Replace ceiling tiles where removal has left holes or cuts in original tiles.
 3. Patch, repair and repaint all walls and surfaces cut, penetrated or otherwise disturbed by the work.
 4. Patch holes and penetrations in masonry and plaster.
 5. Provide suitable coverplates for all recessed backboxes of equipment removed and not covered by new devices.
 6. Provide larger trim or cover plates for new devices, where old backboxes, holes, etc. are not concealed by new work.
 7. Patch finished surfaces and building components using new materials matching existing materials and experienced Installers qualified with the materials and methods required for the surface and building components being patched.
- B. Disturbance of Existing Fire Proofing:
1. Where work of this contract causes disturbance, damage or removal of any existing fire proofing material, the contractor shall restore the original fireproofing after work is completed. Fire proofing shall be as specified in another section of the contract specifications, or shall match existing.

3.8 FIELD QUALITY CONTROL

- A. General:
1. Provide all circuits free from ground faults, short circuits and open circuits
 2. Perform tests specified or required to demonstrate that the work is installed and operating properly.
 3. Where specific tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.
 4. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.
- B. Inspections:
1. Schedule, pay for (as applicable) and attend all inspections required by the Authorities Having Jurisdiction start of work.
 2. Deliver all certificates to the Owner prior to final acceptance of work.
 3. Notify Architect in advance of scheduled inspections.
 4. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled electrical inspections.
 5. Schedule preliminary and rough-in inspections in a timely manner. Any work covered prior to any inspection in a manner which, in the inspector's opinion, precludes a complete inspection, shall be uncovered at the installer's cost.
 6. Uncover Work to provide for installation of ill-timed Work.
 7. Disconnect installed work as specified for testing.
- C. Acceptance Testing: Provide for acceptance testing of electrical equipment, as follows, and as required in other electrical Division specification sections.
1. Pay for and schedule all required acceptance testing.
 2. Testing shall be by independent electrical testing contractor, licensed and certified by NETA.
 3. Testing company shall be independent of installing company (i.e. no

subsidiaries).

4. All tests shall be performed in accordance with the National Electrical Testing Association (NETA).
5. Notify Architect and Owner in advance of all testing.
6. Deliver all reports to Architect for approval.
7. Retest all failed equipment after adjustment, repairs, etc.
8. Provide all fuel, labor, etc. required for tests.
9. All costs associated with preparations for actual testing shall be borne by the installer.
10. Provide letter or statement on Testing Agency letterhead attesting to the satisfactory test results and suitability of the equipment to be energized and/or placed into service, as applicable. If testing reveals any problems or marginal results, the letter shall state these.

D. Replacement of Faulty Work or Materials:

1. Replace any equipment, which fails NETA test results at the direction of the Owner. All replaced equipment shall be retested at no cost to Owner.
2. Remove and replace all defective Work or materials.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Materials not installed per recognized standards, manufacturers' instructions, contract documents or design intent shall be removed and replaced when so directed by the Architect, at the Contractor's expense.

- E. Project Punchout Inspection: Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/ Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement shall be made by deducting the Architect/Engineer's fee from the Contractor's final payment.

3.9 ADJUSTING

A. General:

1. Lubricate, clean, adjust and test all equipment and systems in accordance with the manufacturer's instructions prior to initial operation.
2. Do not operate equipment unless proper safety devices and controls are operational.
3. Provide all maintenance and service for equipment, which is operated during construction, and protect the equipment.
4. Provide services of the manufacturer's factory-trained technicians to start up the equipment where required, or specified.

3.10 IDENTIFICATION

A. Permanently identify all equipment in accordance with the project nomenclature.

1. Panelboards - identify panel as per contract, voltage, and emergency or UPS power, as applicable.

2. i.e. PANEL RP1
120/208 VOLTS
EMERGENCY POWER
 3. Starters, disconnects - identify fan, pump or load served, using contract nomenclature.
i.e. EXHAUST FAN NO. 1
 4. Miscellaneous controls, terminal boards, etc.
i.e. FIRE ALARM POWER SUPPLY
 5. General purpose receptacles - identify branch circuit panel and circuit number on back of coverplate with permanent marker.
 6. Kitchen receptacles - identify branch circuit panel and circuit number on front of coverplate with machine printed label (i.e. Brother P-Touch, or equal).
- B. Identify all power conductors via colored insulation, or individual identification of phase wires with colored electrical tape at each junction box, panel or enclosure where conductors are visible. Color coding as listed below, on all building wiring and feeders:
1. 208/120-V System: As follows:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
 2. 480/277-V System: As follows:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray.
 - e. Ground: Green.
- C. Manhole/Handhole Cable Identification:
1. Identify all individual cables and phases in all handholes and manholes.
 - a. Provide stamped stainless steel tags.
 - b. Attach with nylon cable ties.
 - c. Include feeder or circuit number, phase, etc.

3.11 LOW VOLTAGE TERMINATION IDENTIFICATION

- A. Permanently identify all cables, wires, terminal boards, terminal blocks and other equipment in accordance with the manufacturer's shop drawings or product data.
- B. Identify all control cables and wires:
 1. All indoor locations:
 - a. Length to permit a minimum of 2-3 revolutions around cable or wire.
- C. Identification shall be applied to both ends of all control cables, wires, etc., within 2 inches of termination. Marking pens, embossed plastic tape markers or other temporary methods will not be acceptable.

3.12 EQUIPMENT MOUNTING

- A. Disconnects & Control Equipment:
 1. In sight of equipment served, with operating handle at 48-54" AFF.

2. As close as practical to motor, etc.
3. For large on-grade or roof mounted equipment, (i.e. chillers, ACU's, etc.), mount to equipment housing or frames.

B. Allow for proper clearance of electrical items and equipment served.

3.13 DEMONSTRATION

A. Provide for equipment manufacturers' established representatives to demonstrate to Owner, the correct operation, safety, adjustments and maintenance of all electrical equipment and systems under this contract.

COMPARABLE PRODUCT SUBMITTAL FORM

Table of Compliance (Sample)
Shop Drawing & Product Data Submittal

1. The Contractor shall prepare a Table of Compliance Form similar in format to the sample shown below to facilitate and expedite the Shop Drawing and Product Data Review. Failure to comply with this requirement will be basis for rejecting the Submittal.
2. The Table of Compliance Form will list and compare the performance parameters as the submitted equipment to that listed on equipment schedule and specifications as basis of design. All non-compliance items (differences) must be explained in full, indicating their impact, if any, on maintainability, durability, energy use, operating costs, code compliance and environmental considerations.

(Sample)
TABLE OF COMPLIANCE

EQUIPMENT: _____ SPEC. SECTION: _____

| BASIS OF DESIGN SAMPLE ITEMS | DRAWINGS | SUBMITTED | EXPLANATION |
|---|----------|-----------|-------------|
| Input KW, amps, etc. | | | |
| Input Voltage range | | | |
| Efficiency rating | | | |
| Heat output (Btu/hr) | | | |
| Overload capability (%) | | | |
| Adjustable Range | | | |
| Battery backup (minutes) | | | |
| NEMA rating or size | | | |
| Material thickness (ga) | | | |
| Interrupting Rating | | | |
| Cable Category (5e, 6) | | | |
| Etc. | | | |
| Specifications: | | | |
| Quality assurance compliance | | | |
| | | | |
| (NEMA) | | | |
| (UL) | | | |
| Specifications: List each and every specification paragraph | | | |
| Etc. | | | |
| Other: | | | |

END OF SECTION

SECTION 26 0526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid grounding of electrical systems and equipment.
 - 2. Basic requirements for grounding for protection of life, equipment, circuits, and systems.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Section 14 21 23 "Elevators," "Escalators," and "Materials Handling" for bonding and grounding requirements.
 - 2. Section 26 05 00 "Common Work Results for Electrical."
 - 3. Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables" for grounding conductors and attachments.
 - 4. Section 26 05 43 "Underground Ducts and Raceways for Electrical."
 - 5. Section 26 20 00 "Low Voltage Electrical Distribution" for grounding, bonding and interconnection of 600V class distribution equipment.
 - 6. Section 26 32 00 "Packaged Generator Assemblies" for grounding, bonding and interconnection of generator and frames.
 - 7. Section 26 36 00 "Transfer Switches" for grounding, bonding and interconnection of neutral conductors within transfer switches.

1.3 SUBMITTALS

- A. Submittal Requirements of this section:
 - 1. Ground Rods.
 - 2. Exothermic Weld materials.
 - 3. Grounding/bonding clamps.
 - 4. Main Electrical Grounding bus bars.
 - 5. Telecomm MDF and IDF ground bus bars.
 - 6. Computer Room Signal Reference Ground mat

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
- B. Installation Quality: In accordance with recognized trade organizations and standards.
 - 1. NFPA 70, "National Electrical Code."
 - 2. UL 467, "Grounding & Bonding Equipment."
 - 3. IEEE.

4. ANSI/EIA/TIA 607, "Commercial Building Grounding and Bonding Requirements for Telecommunications."

1.5 SEQUENCING

A. General Sequencing:

1. Install all subsurface grounding equipment after completion of grading and excavations to avoid disturbance of components.

1.6 WARRANTY

- ### A. Provide warranty in accordance with the General Conditions, Division 01 requirements, Section 260500 "Common Work Results for Electrical" and as stated herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- #### A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. A.B. Chance Co.
2. Cooper Power Systems
3. O-Z/Gedney Co.
4. Erico Cadweld
5. Harger

2.2 GROUNDING AND BONDING PRODUCTS

- #### A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
- #### B. Conductor Materials: Copper.

2.3 WIRE AND CABLE CONDUCTORS

- #### A. General: Comply with Section "Low Voltage Power Conductors and Cables." Conform to NEC, except as otherwise indicated, for conductor properties, including stranding.
- #### B. Grounding Electrode Conductor: Stranded cable.
- #### C. Insulated Ground Wire:
1. Minimum sizes per NEC or larger as indicated.
 2. Quantities and sizes as per drawings.
 3. Green insulation.
- #### D. Bare Ground Wires:
1. For equipment bonding jumpers, equipment enclosures to the ground bus or lug, bonding conduit grounding fitting, and elsewhere as required.
 2. # 6 AWG minimum for bonding jumpers.
 3. Solid Conductors: Soft or annealed per ASTM B3, "Soft or Annealed Copper"

- Wire.”
4. Stranded copper per ASTM B8, “Concentric Lay Stranded Copper Conductors.”

2.4 MISCELLANEOUS CONDUCTORS

- A. Ground Bus: Bare annealed copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 30 gauge bare copper wire, terminated with copper ferrules.
- C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.5 GROUNDING ELECTRODE SYSTEM MAIN GROUND BUS BAR

- A. Bus bar shall serve as the main grounding point for the grounding electrode system, and shall provide a visible connection point for all interconnected ground and bond equipment.
 1. Bare annealed copper bars of rectangular cross section, 1/4" thick x 2" H x 18" L.
 - a. Pre-drilled for single and double-hole, solderless lug connectors.
 2. Insulated standoff mounting brackets with 1-1/2" insulators and 1" offset stainless steel bolts for rigid support.
 3. Erico, or comparable product by Harger or Burndy.

2.6 TELECOMM BACKBOARD GROUNDING BAR

- A. Provide grounding bar at all telecomm backboards for common ground connections of frames, racks, switches, lightning protectors, etc.
 1. Bare aluminum ground bar of rectangular cross section, 1/4" thick x 3/8" H x 4" L.
 2. Minimum of ten (10) pre-drilled holes with compression screws for mechanical termination of ground wires.

2.7 CONNECTOR PRODUCTS

- A. General: Listed and labeled as grounding connectors for the materials used.
- B. Pressure Connectors: High-conductivity-plated units.
- C. Bolted Clamps: Heavy-duty units listed for the application.
- D. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

2.8 GROUNDING ELECTRODES

- A. Ground Rods:
 1. One piece, copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.
 2. Size: 3/4 inch by 10 feet.

2.9 FLEXIBLE BONDING STRAPS

- A. Flexible grounding/bonding straps for water meter jumpers, raised floor bonding, etc.
 - 1. Flexible, tinned, pure copper braid.
 - 2. Unplated, seamless pure copper rectangular ferrules at each end.
 - 3. Burndy Type B, or equal.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Equipment Grounding Conductor Application: Comply with NEC Article 250, "Grounding" for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.
 - 1. Feeders and Branch Circuits: Install separate insulated equipment grounding conductors with circuit conductors. Terminate on panelboard or switchboard grounding bus bar, or on ground lug or bus in equipment enclosure, cabinet, etc. Splicing of equipment grounding conductors is not permitted.
 - 2. Panelboards: All equipment grounding conductors shall terminate on a single ground busbar within the equipment enclosure. Bus bar shall be bonded to enclosure.
 - 3. Nonmetallic Raceways: Provide insulated equipment ground conductor in raceways with each branch circuit unless raceway is designated for telephone or data cables.
 - 4. Air Duct Equipment Circuits: Provide insulated equipment grounding conductor to duct-mounted electrical devices operating at 120VAC and above, including humidifiers, air cleaners, heaters, etc. Bond the grounding conductor to each such unit and to the air duct.
 - 5. Heat Tracing and Snow Melting Cables: Provide separate insulated equipment ground conductor for each electric heat tracing or snow melting cable. Bond this conductor to cable connection box, and to piping or other connected metallic equipment or components. Provide ground fault protection for heat tracing and snow melting circuits, per NEC.
 - 6. Water Heaters: Provide separate insulated equipment ground conductor to each electric water heater. Bond grounding conductor to water heater and connected piping.
- B. Underground Conductors: Bare, stranded copper except as otherwise indicated.
- C. Telecommunications: Provide ground at all closets, server or IT rooms, MDF, IDF and equipment frame locations per ANSI EIA/TIA-607, "Commercial Building Grounding and Bonding Requirements for Telecommunications" and as specified herein.
 - 1. Provide grounding system which bonds all remote equipment rooms, racks, cabinets and/or frames to a ground bar in the main equipment room per ANSI.
 - 2. All IDF and similar telephone/data room locations:
 - a. Provide TGB with insulated, standoff brackets. Mount 18" AFF.
 - b. Bond directly to the TMGB via #3/0 AWG TBB conductor, following the same route as the backbone or riser cables.
 - c. Provide additional bond to nearest vertical steel column via exothermic weld.
 - 3. Provide a Telephone Bonding Backbone (TBB) conductor to link closet or room TGB's located remote from the TMGB. The TBB shall consist of the following:
 - a. #3/0 AWG stranded, insulated copper wire installed along the same path as the telecomm riser or backbone cables.
 - b. Bond directly to the TMGB.

- c. Bond to each TGB in closets or rooms through which the TBB passes.
 - 4. All grounding and bonding conductors shall be stranded copper, with green insulation (or black with green identification at all connection points).
 - 5. All connections to TMGB and TGB's shall utilize hydraulic crimped copper lugs, with bolted connections to bus bars.
 - 6. All connections to steel columns shall be made with exothermic weld process.
 - 7. Split-bolt connectors are not permitted for any connections.
 - 8. Bonding conductors shall be continuous between connection points. Do not splice bonding conductors.
 - 9. Do not install in metallic conduit. Where physical protection is required, utilize PVC conduit (except in plenums).
- D. Metal Lighting Poles: Ground pole to a local driven ground rod and bond to equipment grounding conductor run with supply branch circuit.
- E. Building Structure & Grounding Electrode System Requirements:
 - 1. Provide bonding jumpers to make all sections of building structural steel electrically continuous per NEC Article 250, "Grounding and Bonding." Connections shall be mechanical or exothermic weld type.
 - 2. Bond building steel to foundation rebar by welding rebar to column, or 500 MCM stranded copper wire with exothermic weld connection to rebar and columns.
 - 3. Provide driven ground electrode (rods). Spacing of multiple rods shall be at least twice the length of each rod.
 - 4. Provide connections to building water services (domestic and fire) via mechanical clamps.
 - 5. Provide UFER Ground (Concrete-encased electrode) at building footing or foundation, as required by NEC Article 250, "Grounding and Bonding."
 - a. Fabricate with minimum of 20 LF of 500 MCM bare copper conductor laid lengthwise in excavation for foundation or footings.
 - b. Install conductor within 2 inches of the bottom of the concrete.
 - c. Where base of foundation is less than 20 feet in length, coil excess conductor at base of foundation.
 - d. Bond conductor to reinforcing steel at four locations, minimum.
 - e. Extend conductor below grade and connect to building grounding grid or grounding electrode.
- F. Dry Transformer Grounding:
 - 1. Ground all transformer components per NEC.
 - a. Secondary neutral.
 - b. Primary and secondary grounding conductors.
 - c. Enclosure.
 - d. Electrostatic shield (shielded units).
 - e. Bond all together and to building steel per NEC Article 250 "Grounding and Bonding".
 - f. Provide equipment ground conductor in primary feeder. Connect to transformer ground lug or bus.

3.2 INSTALLATION

- A. General: Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.
- B. Ground Rods:

1. Locate a minimum of two-rod lengths from each other and at least the same distance from any other grounding electrode.
 2. Interconnect ground rods with bare conductors buried at least 24 inches below grade.
 3. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated.
 4. Make connections without damaging the copper coating or exposing the rod steel.
 5. Drive rods until tops are 6 inches below finished floor or final grade except as otherwise indicated.
- C. Metallic Water Service Pipe:
1. Provide insulated copper ground conductors, sized as indicated, in conduit from the building main service equipment, or the ground bus, to main metallic water service.
 2. Connect ground conductors to the main metallic water service pipes by means of ground clamps.
 3. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fitting. Do not install a grounding jumper around dielectric fittings.
 4. Bond the ground conductor conduit to the conductor at each end.
- D. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

3.3 CONNECTIONS

- A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. 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 assure high conductivity and make contact points closer in order of galvanic series.
 2. Make connections with clean bare metal at points of contact.
 3. Aluminum to steel connections shall be with stainless steel separators and mechanical clamps.
 4. Aluminum to galvanized steel connections shall be with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections involving dissimilar details with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
 6. Aluminum conductors shall have antioxidant coatings at all connections and shall have UL Listed AL-CU lugs as needed.
 7. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torque requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors" and 486B, "Wire Connectors for Use with Aluminum Conductors."
- B. Exothermic Welded Connections:
1. Use for connections to structural steel and for underground connections of conductors and rods.
 2. Install at connections to ground rods and plate electrodes.

3. Comply with manufacturer's written recommendations.
 4. Re-make any welds that are puffed up or that show convex surfaces indicating improper cleaning.
- C. Conductor Terminations:
1. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs.
- D. Metallic Raceways:
1. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing.
 2. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing.
 3. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
- E. Compression-Type Connections:
1. Use hydraulic compression tools.
 2. Use tools and dies recommended by the manufacturer of the connectors.
 3. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.
- F. Moisture Protection:
1. Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.
- 3.4 PAD-MOUNTED EQUIPMENT GROUNDING
- A. Padmounted Transformers and Switchgear:
1. Provide a minimum of two (2) driven rods, installed at opposite corners.
 2. Interconnect with #4/0 AWG BCSD counterpoise at 24" depth.
 3. Exothermic weld connections.
 4. Provide ground conductor from one rods thru PVC conduit sleeve in bottom of pad to equipment ground bus connection.
- 3.5 MEDIUM VOLTAGE DUCTBANK SYSTEM GROUNDING
- A. Ground underground medium voltage cable system per NEC and other applicable federal, state and local electric codes, and as follows:
1. Provide a 600 volt insulated, stranded copper ground wire.
 2. THW or THWN insulation.
 3. Install in duct with each MV cable.
 4. Bond at each switch, manhole or termination point.
 5. Minimum #1/0 AWG, or as indicated.
- 3.6 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Manholes & Large Handholes:
 - 1. Provide driven ground rod thru hole in bottom of manhole, close to one wall.
 - 2. Install rod such that 4 inches will extend above the finished floor.
 - 3. Where necessary, install ground rod before the manhole is placed and provide a No. 1/0 bare copper conductor from the ground rod into the manhole through a waterproof sleeve in the manhole wall.
 - 4. Protect rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below the concrete.
 - 5. Seal floor opening with waterproof non-shrink grout.

- B. Connections of Manhole/Handhole Components:
 - 1. Connect all exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole to the ground rod or ground conductor.
 - 2. Make connections with minimum No. 4 AWG stranded hard-drawn copper wire.
 - 3. Provide exothermic weld connection to rod.
 - 4. Provide mechanical clamp connections to ladders, racks, etc.
 - 5. Train conductors plumb or level around corners and fasten to manhole walls.
 - 6. Connect to cable armor and/or cable shields by means of tinned terminals soldered to the armor or shield, or as recommended by manufacturer of splicing and termination kits.

- C. Grounding System: Ground non-current-carrying metallic items associated with manholes, substations, and pad-mounted equipment by connecting them to bare underground cable and grounding electrodes arranged as indicated.

3.7 REPAIR/RESTORATION

- A. Restore all areas or surfaces disturbed by work of this contract, to pre-existing conditions.
 - 1. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated.
 - 2. Where sod has been removed, replace it as soon as possible after backfilling is completed.
 - 3. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition.
 - 4. Include necessary topsoil, fertilizing, liming, seeding, sodding, sprigging, or mulching.
 - 5. Restore disturbed paving as indicated, and as required.

3.8 FIELD QUALITY CONTROL

- A. General:
 - 1. Before making tests, complete all connections at panels, fixtures and other equipment.
 - 2. Install fuses and have all wiring continuous from service equipment to utilization outlets.
 - 3. Correct all undesirable ground, open and short circuit conditions.
 - 4. Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.

- B. Acceptance Testing: Take and record the following readings on applicable systems, as

described below:

1. Site Tests:
 - a. Provide tests of the completed grounding system using a megohmmeter at each location where a maximum ground resistance level is specified.
 - b. Measure ground resistance at least 48 hours after any precipitation and without the soil being moistened by any other natural or artificial means.
 - c. Tests shall be performed without chemical treatment or other artificial means of reducing natural ground resistance.
 - d. Perform test by the Fall of Potential (3-point) method in accordance with IEEE 81 Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System.
2. Ground resistance maximum values shall be as follows:
 - a. Building Grounding electrode driven rods:
 - b. Rated 500 kVA and less: 10 Ohms
 - c. Rated >500 kVA: 5 Ohms
 - d. Lighting pole grounds: 15 Ohms
 - e. Manhole grounds: 10 Ohms
1. Feeder Equipment Grounding Conductor Tests:
 - a. Perform test by the 2-point method to verify impedance in the ground system between installed components, including, but not limited to the following:
 - 1) Medium Voltage switchgear or transformers and main grounding busbar.
 - 2) Service switchgear, switchboard, panelboard or transformer and main grounding busbar.
 - 3) Branch panelboards to feeder source.
 - 4) Dry transformers to primary feeder source.
 - 5) Grounding equipment riser(s) (for transformers) from farthest point to point of connection at building main grounding busbar, switchboard ground, or other source connection point.
2. Neutral-Ground Bond Testing:
 - a. Test distribution system for presence of neutral-to-ground bonds at points other than service entrance and/or separately derived sources.
 - b. Remove permitted N-G bond at point of common coupling, and verify no continuity between neutral and ground systems.
 - c. Record the measured isolation (megohms) between the neutral and ground systems.
 - d. Where continuity is found, provide further investigation to locate and remove such bonds.

3.9 ADJUSTING

- A. General:
 1. Make and perform all adjustments after all building grounding systems are complete.
- B. Deficiencies of Service or Building Ground Systems:
 1. Where ground resistance exceeds specified values, notify the Architect immediately.
 2. Modify the grounding system to reduce resistance values.
 3. Provide additional ground rods, interconnected with the others, installed at least 10 feet between rods.
 4. Retest ground resistance after modifications.

5. Where values still exceed those specified, the Architect will provide additional direction.
- C. Unintentional Bonding of Grounds, Neutrals, etc. of Service or Building Ground Systems:
1. Perform additional testing and measurements to locate the unintentional bonds.
 2. Remove unintentional bonds.
 3. Retest system(s) to prove desired isolation of systems.
- D. Reports:
1. Prepare test reports, certified by the testing organization, of the ground resistance at each test location.
 2. Include observations of weather and other phenomena that may affect test results.
 3. Indicate measures taken to improve test results.
 4. Provide all final measurements of system isolation tests (megohms).

END OF SECTION

SECTION 26 0529
SUPPORTING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Work of this Section consists of the furnishing and installation of secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals and associated fastenings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit.
 - b. American Electric.
 - c. B-Line Systems, Inc.
 - d. Cinch Clamp Co., Inc.
 - e. GS Metals Corp.
 - f. Haydon Corp.
 - g. Kin-Line, Inc.
 - h. Unistrut Diversified Products.
 2. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Cooper Industries, Inc.
 - c. Elliott Electric Mfg. Corp.
 - d. GS Metals Corp.
 - e. Killark Electric Mfg. Co.
 - f. Madison Equipment Co.
 - g. L.E. Mason Co.
 - h. O-Z/Gedney.
 - i. Producto Electric Corp.
 - j. Raco, Inc.
 - k. Red Seal Electric Corp.
 - l. Spring City Electrical Mfg. Co.
 - m. Thomas & Betts Corp.

2.2 COATINGS

- A. Coating: Supports, support hardware and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets and spring steel clamps.
- B. Fasteners: Types, materials and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
 2. Toggle Bolts: All steel springhead type.
 3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 16-gauge steel channels with $\frac{9}{16}$ " diameter holes, at a minimum of 8" on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

2.4 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snap-lock joint, welded spiral seams or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
 - a. 3" and smaller: 20-gauge.
 - b. 4" – 6": 16-gauge.
 - c. Over 6": 14-gauge.
 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC Requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
1. Conform to Manufacturer's recommendations for selection and installation of supports.
 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs. Safety allowance in the strength of each support.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments and other hardware necessary for
 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1½" and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use ¼" diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 6. Space supports for raceways in accordance with NEC and local authorities having jurisdiction.
 7. Support exposed and concealed raceway within one foot (1') of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors.
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers and other devices.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24" from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls, for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL Listed fire-stopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Resistant Joint Sealers" requirements of other divisions of these Specifications.
- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry and machine screws, welded threaded studs or spring tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps or items other than threaded studs to

- steel structures. Do not weld conduit, pipe straps or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
2. Holes cut to depth of more than 1½" in reinforced concrete beams or to depth of more than ¾" in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25% of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
- J. Tests: Test pullout resistance of one of each type, size and anchorage material for the following fastener types:
1. Expansion anchors.
 2. Toggle bolts.
 3. Powder-driven threaded studs.
- K. Provide all jacks, fixtures and calibrated indicating scales required for reliable testing. Obtain the Structural Engineer's approval before transmitting loads to the structure. Test to 90% of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

END OF SECTION

SECTION 26 0533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Conduits.
 - 2. Conduit fittings and supports.
 - 3. Wireways.
 - 4. Device and outlet boxes.
 - 5. Pull and splice boxes.
 - 6. Floor mounted devices.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Section 26 05 00 "Common Work Results for Electrical."
 - 2. Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables" for conductors to be installed in raceways.
 - 3. Section 26 05 26 "Grounding & Bonding for Electrical Systems" for coordination with grounding equipment and attachments.

1.3 SUBMITTALS

- A. Submittal Requirements of this section:
 - 1. Conduits.
 - 2. Floor mounted devices.
- B. Descriptive Data:
 - 1. To verify specifications have been met/exceeded.
 - 2. Indicate UL listing for all products.
 - 3. Manufacturer's specifications, data sheets.
 - 4. Catalog cuts.
 - 5. Dimensional drawings.
 - 6. Capacity ratings.
 - 7. Information required indicating contract compliance.
 - 8. Clearly indicate the exact size or rating proposed.
- C. Closeout Submittals: Submit in accordance with the General Conditions and Division 1 requirements.

1.4 DELIVERY, STORAGE AND PROTECTION OF EQUIPMENT

- A. Packing, Shipping, Handling and Unloading:

1. Transport and handle all equipment to prevent bending, distortion or damage to products.
- B. Storage and Protection:
1. Store all materials out of rain.
 2. Protect from physical damage.
 3. Guard against nicks and scratches on finished surfaces.

1.5 WARRANTY

- A. Provide warranty in accordance with the General Conditions, Division 01 requirements, Section 260500 "Common Work Results for Electrical" and as stated herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, provide the named "Basis of Design" manufacturer and model ("Basis of Design" fixtures are indicated on the drawing fixture schedule), or a comparable product of one of the other following named manufacturers:
1. Steel Conduits & Fittings:
 - a. Allied Tube & Conduit
 - b. American Electric/Steel City
 2. Non-Metallic Conduits & Fittings:
 - a. Carlon
 - b. Cantex
 3. Floor mounted devices:
 - a. Wiremold
 - b. Hubbell
 - c. MonoSystems, Inc.

2.2 METAL CONDUIT AND TUBING

- A. Rigid Galvanized Steel Conduit (RGS):
1. ANSI C80.1 Rigid Steel Conduit, Hot dip Galvanized
 2. UL 6 Electrical Rigid Metal Conduit - Steel.
 3. Meets NEC Article 344, "Rigid Metal Conduit."
 4. Material: Steel heavy-wall, hot dip galvanized inside and outside.
 5. Joints: Standard pipe thread; furnished with coupling; shipped with thread protector through 2-inch size.
 6. Minimum Size: 3/4 inch.
- B. Intermediate Metal Conduit (IMC):
1. ANSI C80.6 Intermediate Metal Conduit - Zinc Coated.
 2. UL 1242 Intermediate Metal Conduit.
 3. Meets NEC Article 342 Intermediate Metal Conduit.
 4. Material: Steel only, intermediate wall thickness, hot dipped galvanized.
 5. Joints: Standard Pipe Thread, furnished with coupling, shipped with thread protector through 2-inch size.
 6. Minimum Size: 3/4 inch.

- C. Electrical Metallic Tubing (EMT):
 - 1. ANSI C80.3 Electrical Metallic Tubing - Zinc Coated.
 - 2. UL 6 Rigid Metal Conduit.
 - 3. Meets NEC Article 358, "Electrical Metallic Tubing."
 - 4. Material: Steel, thin-wall, electro-galvanized.
 - 5. Minimum Size: 3/4 inch.

- D. Flexible Metal Conduit (Greenfield):
 - 1. Zinc-coated steel.
 - 2. UL 1 Flexible Metal Conduit.
 - 3. Meets NEC Article 350, "Flexible Metal Conduit."
 - 4. Material: Steel, hot dip galvanized.
 - 5. Minimum Size: 3/4 inch.

- E. Liquid tight Flexible Metal Conduit (Sealtite):
 - 1. UL 360 Liquidtight Flexible Steel Conduit.
 - 2. Meets NEC Article 351, "Liquidtight Flexible Metal Conduit and Liquidtight Flexible Nonmetallic Conduit."
 - 3. Flexible steel conduit with PVC jacket.
 - 4. Galvanized flexible steel core.
 - 5. Extruded PVC jacket, gray or black.
 - 6. Minimum Size: 3/4 inch.

2.3 NONMETALLIC CONDUIT AND TUBING

- A. Rigid Nonmetallic Conduit (RNC):
 - 1. Schedule 40 or 80 PVC.
 - 2. Meeting NEMA publication TC-2, "Electrical Plastic Tubing" (EPT) and "Conduit" (EPC-4 and EPC-80).
 - 3. UL-651 Schedule 40 and 80, "Rigid PVC Conduit."
 - 4. Material complies with ASTM D 1784, "Standards for PVC compounds and CPVC compounds."
 - 5. Meets NEC Article 352, "Rigid PVC Conduit."

- B. Flexible Nonmetallic Raceway (HDPE):
 - 1. Nonmetallic flexible raceway manufactured from High Density Polyethylene (HDPE).
 - 2. Smooth interior and exterior construction.
 - 3. ETL Listed, Schedule 40 1" – 4".
 - 4. UL Listed 651 A & B.
 - 5. Meets NEC Article 353, "High Density Polyethylene Conduit: Type HDPE Conduit."
 - 6. Suitable for directional boring specified for this project.
 - 7. Carlon HDPE conduits, or equal.

2.4 CONDUIT FITTINGS

- A. All fittings to match conduit material and to be suitable for the purpose intended. All fittings shall be UL Listed.

- B. Hazardous Location seal off fittings:
1. Compound filled, malleable iron.
 2. Class & Division as required
 3. 40% fill capacity.
 4. Listed under UL 886, "Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations", vertical or horizontal application, as required.
 5. Crouse Hinds, OZ Gedney, Killark.
- C. Expansion Fittings:
1. Weather tight construction.
 2. Copper braid bonding strap & clamps.
 3. Crouse Hinds, or equal.
- D. RGS/IMC Fittings:
1. Threaded with insulated bushings.
 2. Galvanized steel or malleable iron.
 3. Double locknuts.
 4. Crouse Hinds, Steel City, Bridgeport, or equal.
- E. EMT Fittings:
1. Compression type "Concretight" or "Raintight."
 2. Zinc plated steel body and steel nut.
 3. Insulated throats.
 4. Setscrew fittings not permitted.
- F. Sealtite Conduit Fittings:
1. Threaded ferrule, malleable iron compression nut and body.
 2. Nylon sealing ring.
 3. NEMA FB-1, "Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies."
- G. Flexible Metal Conduit/MC Cable Fittings:
1. 360° squeeze type.
 2. Malleable iron or cast zinc bodies.
 3. Insulated throat.
 4. Anti-short bushings
- H. PVC Conduit Fittings:
1. Formed PVC, sunlight and UV resistant, UL Listed.
 2. Schedule 40 or 80 to match conduit or tubing type and material.
 3. Material complies with ASTM D 1784, "Standards for PVC compounds and CPVC compounds."
 4. Meets NEC Article 347, "Rigid Nonmetallic Conduit."
 5. Meeting NEMA publications TC-3, "PVC Fittings for use with Rigid PVC Conduit and Tubing."
 6. Fittings Listed under UL-514B, "Fittings for Cable and Conduit."
 7. Conduit and elbows with factory belled end.
 8. Carlon Plus 40 conduit and fittings, or equal.

2.5 CONDUIT SUPPORTS

- A. Single suspended feeder conduit:
 - 1. 1/2" - 2" Conduit: Adjustable hangers with 3/8" rods.
 - 2. > 2" Conduit: Adjustable hangers with 1/2" rods.
 - 3. Kindorf C-149 or C-150, B-line, or equal.
- B. Groups of suspended conduits:
 - 1. Steel channels with conduit straps.
 - 2. 2" threaded rods, minimum.
 - 3. Kindorf, B-Line, or equal.
- C. Flexible metal conduit, MC Cable:
 - 1. UL Listed Caddy Clips, or similar attachment methods.
- D. Surface mounted conduit:
 - 1. 1 or 2-hole pipe straps.

2.6 WIREWAYS

- A. Material: Sheet metal sized and shaped as indicated.
- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireway as required for complete system.
- C. Wireway Covers: Hinged type, secured with stainless steel screws.
- D. Finish: Manufacturer's standard enamel finish, ANSI 49 or 61 gray.
- E. NEMA Rating:
 - 1. NEMA 1 for dry, indoor locations.
 - 2. NEMA 3R for outdoor or areas exposed to weather or severe moisture.

2.7 DEVICE & OUTLET BOXES

- A. Indoor boxes - zinc-coated or cadmium plated steel, NEMA OS-1.
- B. Unheated, "damp" and "wet" locations and outdoor locations:
 - 1. NEMA 4X PVC.
 - 2. Glue-in conduit hubs.
 - 3. Gasketed coverplates.
 - 4. Sunlight (UV) resistant.
- C. Outlet boxes in un-plastered brick or block walls shall be provided with deep square-cut device covers.
- D. Furnish all boxes with appropriate covers.
- E. No sectionalized boxes shall be used.

2.8 TELECOMMUNICATION OUTLET BOXES

- A. Back boxes:
 - 1. Recessed outlets:
 - a. 4" x 4" x 2-1/2" deep steel, recessed device box.
 - b. Single-gang steel reducer plate (plaster ring).
 - 2. Surface mounted outlets:
 - a. Single or multi-gang box as required by drawings and application.
 - b. NEMA 1 smooth steel construction.
 - c. Ivory finish to match surface raceways.
 - d. Concealed knockouts for entry of surface raceway.
 - e. No visible or open unused knockouts.
 - f. Minimum 1 3/4" deep.
 - g. Wiremold # V5748.

2.9 JUNCTION AND PULL BOXES

- A. Dry locations:
 - 1. 12 gauge galvanized sheet steel minimum.
 - 2. Flat covers secured in position by round head brass or stainless steel 300 grade machine screws.
 - 3. NEMA OS-1, "Sheet Steel Outlet Boxes, Covers and Box Supports."
- B. Exterior and wet locations:
 - 1. Cast aluminum or galvanized cast-iron type.
 - 2. Threaded hubs.
 - 3. Gasketed screw-on cover plates.
 - 4. NEMA FB-1, "Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies."
- C. Boxes imbedded in concrete:
 - 1. NEMA 4X PVC.
 - a. Glue-in conduit hubs.
 - b. Gasketed coverplates.
 - c. Sunlight (UV) resistant.
- D. All boxes sized to meet the requirements of the NEC.

2.10 FLUSH SINGLE SERVICE FLOOR BOXES

- A. Complete, flush, in-floor box consisting of floor box housing, flush removable coverplate, wiring device as indicated, all fittings, materials and labor.
- B. Coordinate exact locations and orientation with Owner prior to concrete pour.
- C. General:
 - 1. Flush mounted, rectangular boxes; single-gang.
 - 2. Brass trim ring for devices in carpeted or tiled areas.
 - 3. Coverplate per box, type as required.
- D. Box Construction:

1. Galvanized steel boxes, 2 3/4" deep.
 2. Concrete-tight for in-floor use.
 3. Adjustable legs to leveling and adjustment prior to pour.
 4. Knockouts for conduit entry and feed through use.
 5. Wiremold Single Series #886, or equal.
- E. Coverplate & Wiring Devices:
1. Single-gang brass carpet/tile coverplate.
 2. Brass device coverplate(s) with duplex fliplid type covers; Walker #895 for duplex, #895GFI for GFI or TVSS outlets.
 3. UL scrub-water compliant.
 4. ADA compliant.
 5. Receptacles, jacks and connectors as specified elsewhere.
- F. Wiremold Single Series Floor Boxes, MonoSystems, or comparable product.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine areas to receive cable trays. Make adjustments to elevations, routing, etc. to coordinate with other work including beams, lights, ducts, pipes, etc.

3.2 APPLICATION

- A. General Exterior Conduit Applications:
 1. Direct buried: PVC, RGS
 2. Above grade, building surfaces: IMC, RGS
 3. Roof surfaces: IMC
 4. Below covered roofs/overhangs: IMC, EMT
 5. Motors, pumps, etc. Sealtite
- B. General Interior Conduit Applications:
 1. All panelboard feeders:
 - a. Above slab: EMT
 - b. Below floor slab: RGS, PVC*
 - 1) *RGS required where conduit penetrates through slab.
 - c. Below raised access floors: EMT
 2. HVAC equipment circuits:
 - a. (>30 amps): EMT
 - b. (≤ 30 amps): EMT, MC Cable
 - c. Below floor slab: RGS, PVC*
 - 1) *RGS required where conduit penetrates through slab.
 3. Branch circuits (lighting, receptacles):
 - a. Above accessible ceilings: EMT, MC Cable
 - b. Above inaccessible ceilings: EMT, MC Cable
 - c. Concealed in CMU walls: EMT, PVC

- d. Within solid masonry walls: EMT, PVC
- e. Concealed within stud walls: EMT, MC Cable
- f. Surface mounted, unfinished areas: EMT
- g. In or below slab on grade to flush floor boxes: PVC
- 4. Final Connections to Lights, dry transformers, small motors, vibrating equipment:
 - a. Indoor, dry locations: Greenfield
 - b. Outdoor, damp locations: Sealtite

3.3 INSTALLATION

A. General:

1. Coordinate layout and installation of all raceways, cable trays, boxes and other equipment with other construction elements to ensure adequate headroom, working clearance, and access and to eliminate interference problems.
2. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
3. Do not cut or drill structural members without permission of Architect. Provide reinforcing for opening as directed by Architect.
4. Pierce metal deck where required for installation of electrical equipment.
5. Support raceways and equipment as required by NEC, manufacturers, and as specified elsewhere.
6. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer.
7. Tighten connectors and terminals, including screws and bolts, per manufacturer's published torque values, or per UL 486A, "Standard for Wire Connectors and Soldering Lugs for Use With Copper Conductors" where not specified.

3.4 CONSTRUCTION

A. Flexible Connections: Use maximum of 6 feet of flexible conduit for connections to equipment subject to vibration, noise transmission, or movement, and for all motors. Use liquid tight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections. Provide flexible connections as follows:

1. Connections to motors between rigid conduit and connection box on motor.
2. Connections to equipment containing motors.
3. Connections to equipment subject to movement caused by rotation, vibration or oscillation.
4. Connections from rigid conduit system to recessed lights.
5. Connections to dry-type transformers.
6. Connections of feeder conduit at bus duct plug-in breaker or switch.
7. Other applications, as indicated.

B. Supports: Provide all supports, hangers, braces and attachments required for the work of this section.

3.5 CONDUIT INSTALLATION

A. General Installation Requirements:

1. Install all conduit concealed, unless not possible.
2. Surface mounting only as approved by Architect.
3. Minimum size 3/4" inch, unless noted otherwise.
4. Minimum 6" clearance from flues, heating pipes, or other hot surfaces above

80°F.

5. Parallel and perpendicular to walls, structural members, ceilings and interior surfaces; install plumb.
6. Polypropylene or nylon pull line in each empty conduit.
7. Use capped bushings or plugs during construction.
8. Clean and cap all conduits left empty for future use.
9. In masonry, install prior to wall construction and accurately set all outlets.
10. On walls below grade, use stand-off brackets. Maintain minimum 2" space between conduit and wall surface.
11. Where conduit passes through exterior walls, floor or roof, install appropriate fittings and materials to make openings watertight. Repair pierced vapor barriers vapor-proof. Provide flashing for each conduit piercing the roof.

B. Exposed Conduit in Exposed Ceiling Areas:

1. Install all conduit tight to underside of deck, above all ducts, piping, etc.
2. Install conduits within joist webbing and through spaces between steel beams and structure, as high as possible.
3. Install parallel with building walls, beams and main structural elements.
4. Minimize offsets by coordinating with other trades prior to installation.
5. Install pull and junction boxes where least visible. Install on far side of ducts, etc., as visible from the majority of room viewpoints.

C. Raceways Embedded in Slabs: Install in slabs only where explicitly shown on drawings. Install in middle third of the slab thickness where practical, and leave at least 1" inch concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Run conduit larger than 1" inch trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.
4. Transition rigid nonmetallic conduit to rigid galvanized steel (RGS) conduit before rising above floor slab.
5. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
6. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6" inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs flush with floor.

D. Flexible Conduit Installation Requirements:

1. Group all flexible conduits running together in bundles with nylon cable ties.
2. Route bundles neatly through ceiling cavities.
3. Avoid constant changes in direction and elevation of bundles.
4. Install perpendicular and parallel to column lines, except for final separation from bundles.
5. Support bundles at regular intervals, per NEC, independent from ceiling hanger wires.
6. Provide adequate clearance above accessible ceiling tiles, minimum of 18."
7. Where flexible conduit or MC cable is used for final connections to motors, lights, etc., maximum length shall be 6 feet.

E. Fittings & Terminations:

1. Provide expansion fittings in all conduit where crossing building expansion joints.
2. Provide expansion fittings in all runs of PVC conduit, a minimum of 1 between every 2 fixed points.
3. Tighten setscrews of threadless fittings with suitable tool. Tighten compression fittings within wrenches.
4. Terminations: Use two locknuts, one inside and one outside the box. Provide insulated bushings or throats.
5. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
6. Sealing Fittings: Install per manufacturer's instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. Install raceway sealing fittings on conduit at the following points and elsewhere as indicated:
 - a. Entering/leaving hazardous locations.
 - b. Passing from warm locations to cold locations, such as the boundaries of refrigerated spaces.
 - c. Where otherwise required by the NEC.

3.6 WIREWAY INSTALLATION

- A. Install per NEC Article 362. Provide hinged connectors to join adjacent lengths. Connect all sections solidly to insure effective grounding of wireway system.
- B. Mount wireway in accessible location, with hinged section facing in proper direction.
- C. Use standard manufactured lengths to fit in available space. Do not cut standard lengths in field. Provide cut-off fitting where non-standard length is required, and cut in field as required.
- D. Clear all obstructions encountered in field. Provide offsets and appropriate fittings as required to clear obstructions.
- E. Provide closing plate at ends of wireway. Install wire retainers in wireway after conductors are in place. Provide adapter where wireway is connected to box and cabinet.
- F. Use 12" section of wireway to pass through wall, to allow maximum accessible length on each side. Provide special escutcheon plate on each side of wall to finish opening neatly.

3.7 DEVICE & OUTLET BOX INSTALLATION

A. General Requirements:

1. Install all boxes plumb and level.
2. Install boxes at heights required. Refer to Section 26 27 26 "Wiring Devices."
3. Install recessed boxes flush with final finished surface.
4. Secure all boxes such that no movement occurs during normal use.
5. Install ceiling mounted boxes with sufficient support and rigidity to prevent movement during normal connecting and disconnecting procedures.
6. Install power and low voltage device boxes at same heights from floor or counters.

3.8 FLOOR MOUNTED DEVICE BOX INSTALLATION

A. Floor Mounted Devices - General:

1. Set floor boxes level and adjust to floor surface.
2. Make adjustments in fittings, lengths and placement during rough in to accommodate structural and architectural elements, and other equipment.
3. Coordinate exact locations and orientation with Owner prior to concrete pour.

B. Flush In-Floor Device Boxes:

1. Set boxes prior to concrete pour.
2. Coordinate exact positions with Architect, Owner and related equipment.
3. Provide separate conduit connections for power and low voltage sections.
4. Protect housing with cover during concrete pour.
5. Adjust for final height and make level after pour.
6. Set trim rings and covers, adjust for flush fit with final floor covering or finish.

3.9 CLEANING

A. General:

1. Remove paint splatters and other spots, dirt, and debris.
2. Touch up scratches and marred finishes to match original finishes.
3. Clean front of all coverplates, etc. using methods and materials recommended by manufacturer.

END OF SECTION

SECTION 26 0534

BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Work of this Section consists of furnishing and installing cabinets, boxes and fittings for electrical installations and certain types of electrical fittings not covered in other Sections. Types of products specified in this Section include:

1. Outlet and device boxes.
2. Pull and junction boxes.
3. Floor boxes and service fittings.
4. Cabinets.
5. Hinged door enclosures.
6. Boxes and fittings for hazardous locations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Floor Boxes:
 - a. American Electric.
 - b. Butler Mfg. Co.
 - c. Cooper Industries, Inc.
 - d. Raco, Inc.
 - e. Thomas & Betts Corp.
2. Cabinets:
 - a. Electric Panelboard, Inc.
 - b. Erickson Electrical Equipment Co.
 - c. Hoffman Engineering Co.
 - d. Parker Electrical Mfg. Co.
 - e. Spring City Electrical Mfg. Co.
 - f. Square D Co.
3. Boxes and Fittings for Hazardous Locations:
 - a. Adalet-PLM.
 - b. Cooper Industries, Inc.
 - c. Killark Electric Mfg. Co.
 - d. OZ/Gedney.
 - e. Robroy Industries, Co.
 - f. Spring City Electrical Mfg. Co.
 - g. Woodhead Industries, Inc.

2.2 CABINETS, BOXES AND FITTINGS – GENERAL

A. Electrical Cabinets, Boxes and Fittings: Of indicated types, sizes and NEMA enclosure classes. Where not indicated, provide units of types, sizes and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

2.3 MATERIALS AND FINISHES

- A. Sheet Steel: Flat-rolled, code-gauge, galvanized steel.
- B. Fasteners for General Use: Corrosion-resistant screws and hardware including cadmium and zinc-plated items.
- C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.
- D. Cast Metal for Boxes, Enclosures and Covers: Copper-free aluminum except as otherwise specified.
- E. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.
- F. Painted Interior Finish: Where indicated, white baked enamel.
- G. Fittings for Boxes, Cabinets and Enclosures: Conform to UL 514B. Malleable iron- or zinc-plated steel for conduit hubs, bushings and box connectors.

2.4 METAL OUTLET, DEVICE AND SMALL WIRING BOXES

- A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical" and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size and depth to suit each location and application.
- B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded-screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.
- C. Cast-Aluminum Boxes: Copper-free aluminum threaded raceway entries and features and accessories suitable for each location including mounting ears, threaded-screw holes for devices and closure plugs.
- D. Cast-Iron Boxes: Iron alloy, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes for devices and closure plugs.
- E. Cast-Iron Floor Boxes: Fully adjustable, waterproof, with threaded raceway entrances, adjusting rings, gaskets and brass floor plates. Where indicated, provide multi-section boxes with individual hinged section covers and provide for a duplex receptacle under one or more of the covers.
- F. Steel Floor Boxes: Sheet steel, concrete tight, fully adjustable, with stamped knockouts, adjusting rings and brass floor plates. Where indicated, provide multi-section boxes with concealed individual section covers under a common flush floor plate. Provide for a duplex receptacle in one of the concealed section covers and a one-inch (1") diameter bushed opening in the other.
- G. Service Fittings for Floor Outlet Boxes: Surface-mounted horizontal, cast aluminum type 3" high, suitable for finished spaces and finished in satin aluminum, except as otherwise indicated. Provide duplex receptacle or 1" bushed opening for telephone or other communications service as indicated. Equip fitting for attaching flat to floor box cover.

2.5 NON-METALLIC OUTLET, DEVICE AND SMALL WIRING BOXES

- A. General: Conform to NEMA OS 2, "Non-metallic Outlet Boxes, Device Boxes, Covers and Box Supports" and UL 514C, "Non-metallic Outlet Boxes, Flush Device Boxes and Covers." Boxes shall be molded PVC units of type, shape, size and depth to suit location and application.
- B. Boxes for Concealed Work: Mounting provisions and wiring entrances to suit installation conditions and wiring method used.
- C. Boxes for Exposed Work: Ultra-violet stabilized, non-conductive, high impact-resistant boxes with integrally molded raceway entrance hubs and removable mounting flanges. Boxes shall be equipped with threaded-screw holes for device and cover plate mounting. Each box shall have a molded cover of matching PVC material suitable for the application.

2.6 PULL AND JUNCTION BOXES

- A. General: Comply with UL 50, "Electrical Cabinets and Boxes," for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.
- B. Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing.
- C. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.
- D. Stainless Steel Boxes: Fabricate of stainless steel conforming to Type 302 of ASTM A 167, "Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip." Where necessary to provide a rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.
- E. Cast-Aluminum Boxes: Molded of copper-free aluminum, with gasketed cover and integral-threaded conduit entrances.
- F. Cast-Iron Boxes: Molded of cast iron alloy with gasketed cover and integral threaded conduit entrances.
- G. Cast non-metallic Boxes: Ultra-violet stabilized, non-conductive, high impact-resistant PVC boxes with gasketed cover and integral mounting flanges.
- H. Boxes Approved for Classified Locations: Cast metal or cast non-metallic boxes conforming to UL 886, "Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations," listed and labeled for use in the specific location classification and with the specific hazardous material encountered. Conduit entrances shall be integral threaded type.

2.7 CABINETS

- A. Comply with UL 50, "Electrical Cabinets and Boxes."
- B. Construction: Sheet steel, NEMA 1 Class except as otherwise indicated. Cabinet shall consist of a box and a front consisting of a one-piece frame and a hinged door. Arrange door to close against a rabbit placed all around the inside edge of the frame with a uniformly close fit between door and frame. Provide concealed fasteners, not over 24" apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or

concealed door hinges not over 24" apart and not over 6" from top and bottom of door. For flush cabinets, make the front approximately $\frac{3}{4}$ " larger than the box all around. For surface-mounted cabinets, make front same height and width as box.

- C. Doors: Double doors for cabinets wider than 24". Telephone cabinets wider than 48" may have sliding or removable doors.
- D. Locks: Combination spring catch and key lock, with all locks for cabinets of the same system keyed alike.

2.8 STEEL ENCLOSURES WITH HINGED DOORS

- A. Comply with UL 50, "Cabinets and Enclosures" and NEMA ICS 6.
- B. "Enclosures for Industrial Controls and Systems."
- C. Construction: Sheet steel, 16-gauge minimum with continuous welded seams. NEMA Class as indicated, arranged for surface mounting
- D. Doors: Hinged directly to cabinet and removable with approximately $\frac{3}{4}$ " flange around all edges, shaped to cover edge of box. Provide handle operated, key locking latch. Individual door width shall be no greater than 24". Provide multiple doors where required.
- E. Mountain Panel: Provide painted removable internal-mounting panel for component installation.
- F. Enclosure: NEMA 12 except as indicated. Where door gasketing is required, provide neoprene gasket attached with oil-resistant adhesive and held in place with steel retaining strips. For all enclosures of class higher than NEMA-1, use hubbed raceway entrances.

2.9 CAST METAL ENCLOSURES WITH HINGED DOORS

- A. Copper-free aluminum with bolted, hinged doors. Where used at hazardous (classified) locations, enclosures shall conform to UL and shall be listed and labeled for the classification of hazard involved.

2.10 MOLDED NON-METALLIC ENCLOSURES WITH HINGED DOOR

- A. General: Molded, glass fiber reinforced high-impact strength polyester with bolt or screw secured doors and solid neoprene gaskets.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.
- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items securely in accordance with Division 16 Section "Supporting Devices."

- D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.
- E. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 APPLICATIONS

- A. Cabinets: Flush-mounted, NEMA enclosure Type 1 except as otherwise indicated.
- B. Hinged Door Enclosures: NEMA Type 12 enclosure except as indicated.
- C. Hinged Door Enclosures Outdoor: Install drip hood, factory tailored to individual units.
- D. Hinged Door Enclosures in Corrosive Locations: NEMA Type 4X metal enclosure.
- E. Hinged Door Enclosures in Corrosive Locations: NEMA Type 4X non-metallic enclosure.
- F. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
 - 1. Interior Dry Locations: NEMA Type 1, sheet steel or non-metallic as permitted by local code.
 - 2. Interior Dry Locations: Sheet steel, NEMA Type 1.
 - 3. Interior Dry Locations: Non-metallic, NEMA Type 1.
 - 4. Locations Exposed to Weather or Dampness: Cast metal, NEMA Type 3.
 - 5. Locations Exposed to Weather or Dampness: Cast metal, NEMA Type 3R.
 - 6. Locations Exposed to Weather or Dampness: Molded PVC or glass fiber reinforced plastic, NEMA Type 3.
 - 7. Locations Exposed to Weather or Dampness: Molded PVC or glass fiber reinforced plastic, NEMA Type 3R.
 - 8. Wet Locations: NEMA Type 4 enclosures.
 - 9. Corrosive Locations: NEMA Type 4X enclosures.
 - 10. Hazardous (Classified) Locations: NEMA type listed and labeled for the location and class of hazard indicated.
- G. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location except as otherwise indicated.
- H. Floor Boxes: In slabs on grade and wet location, use NEMA Type 4 boxes. At other locations in slabs, use concrete-tight NEMA 1 boxes.

3.3 INSTALLATION OF OUTLET BOXES

- A. Outlets at Windows and Doors: Locate close to window trim. For outlets indicated above door, use 6'-9" mounting height above finished floor and clear for future installation of partitions.
- B. Column and Pilaster Locations: Locate outlet boxes for switches and receptacles on columns or pilasters so the centers of the columns are clear for future installation of partitions.
- C. Locations in Special Finish Materials: For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, use rectangular-shaped boxes with square corners and straight

sides. Install such boxes without plaster rings. Saw cut all recesses for outlets boxes in exposed masonry walls.

- D. Gasketed Boxes: At the following locations use cast-metal, threaded hub-type boxes with gasketed weatherproof covers:
 - 1. Exterior locations.
 - 2. Where surface mounted on unfinished walls, columns or pilasters. (Cover gaskets may be omitted in dry locations.)
 - 3. Where exposed to moisture-laden atmosphere.
 - 4. At food preparation equipment within 4' of steam connections.
 - 5. Where indicated.
- E. Cast-Iron Boxes: Iron alloy, waterproof with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded-screw holes for devices and closure plugs.
- F. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles either vertically or horizontally but consistently either way as directed by Architect. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges and close to door trim, even though electrical floor plans may show them on hinge side.
- G. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4" square by 1½' deep, minimum.
- H. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.
- I. Protect outlet boxes to prevent entrance of plaster and debris. Thoroughly clean foreign material from boxes before conductors are installed.
- J. Concrete Boxes: Use extra deep boxes to permit side conduit entrance without interfering with reinforcing, but do not use boxes with over 6" depth.
- K. Floor Boxes: Install in concrete floor slabs so they are completely enveloped in concrete except for the top. Where normal slab thickness will not envelop box as specified above, provide increased thickness of the slab. Provide each compartment of each floor box with grounding terminal consisting of a washer-in-head machine screw, not smaller than No. 10-32, screwed into a tapped hole in the box. Adjust covers of floor boxes flush with finished floor.
- L. Existing Outlet Boxes: Where extension rings are required to be installed, drill new mounting holes in the rings to align with the mounting holes on the existing boxes where existing holes are not aligned.

3.4 INSTALLATION OF PULL AND JUNCTION BOXES

- A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8" square by 4" deep. Do not exceed six entering and six leaving raceways in a single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed the following:

| <u>Size of Largest Conductors in Box</u> | <u>Maximum No. of Conductors in Box</u> |
|--|---|
| No. 4/0 AWG | 30 |

| | |
|--------------|----|
| 250 MCM | 20 |
| 500 MCM | 15 |
| Over 500 MCM | 10 |

1. Cable Supports: Install clamps, grids or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30" inside boxes.
2. Mount pull boxes in inaccessible ceilings with the covers flush with the finished ceiling.
3. Size: Provide pull and junction boxes for telephone, signal and other systems at least 50% larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

3.5 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES

- A. Mount with fronts straight and plumb.
- B. Install with tops 78" above floor.
- C. Set cabinets in finished spaces flush with walls.

3.6 GROUNDING

- A. Electrically ground metallic cabinets, boxes and enclosures. Where wiring to item includes a ground conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.

3.7 CLEANING AND FINISH REPAIR

- A. Upon completion of installation, inspect components. Remove burrs, dirt and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.
- B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray Manufacturer.
- C. Painted Finish: Repair damage using matching, corrosion-inhibiting touch-up coating.

END OF SECTION

SECTION 26 0543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL

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. Utility coordination.
2. Marker tape.
3. Underground ductbanks.
4. Direct Buried conduit.
5. Directional bored conduit.
6. Handholes.

B. Related Sections:

1. Section 26 05 00 "Common Work Results for Electrical" for concrete pads, bollards and other related equipment.
2. Section 26 05 19 "Low Voltage Power Conductors and Cables" for grounding conductors and attachments.
3. Section 26 05 26 "Grounding and Bonding For Electrical Systems" for ground rods, grounding and bonding requirements of utility structure components.
4. Section 26 05 33 "Raceways and Boxes For Electrical Systems" for conduit specifications.
5. Section 26 12 00 "Medium Voltage Transformers" for related equipment installed in or on the ground.

1.3 SUBMITTALS

A. Submittal Requirements of this section:

1. Utility Marker Tape
2. Ductbank spacers
3. Handholes, covers & accessories

B. Product data, including construction, materials, ratings, etc.

C. Submit the following for each handhole:

1. Manufacturer/cat. number.
2. Manufacturer's dimensional drawing(s).
3. Indicate open or closed bottom.
4. Type, rating, color and labels of covers.
5. Type and material of lid hardware.
6. Additional information to show compliance with specifications or drawings.

D. Product Test Reports: Certified copies of handhole or manhole manufacturer's design,

factory tests, required by the referenced standards.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms “Listed and Labeled”: As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.
- B. Manufacturer/Vendor Requirements:
 - 1. Coordinate the components of the system and their arrangements electrically and mechanically.
- C. Installation Quality: In accordance with recognized trade organizations and standards.
 - 1. ANSI (American National Standards Institute)
 - 2. NEC (National Electrical Code)
 - 3. NECA “Standards of Installation”
 - 4. NEMA (National Electrical Manufacturers Association)

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Provide all transportation of equipment to site.
 - 2. Provide for rigging needed for unloading, and setting large manholes or handholes into final position.
- B. Storage and Protection:
 - 1. Protect all utility structures from damage prior to installation.

1.6 WARRANTY

- A. Provide warranty in accordance with the General Conditions, Division 01 requirements, Section 260500 “Common Work Results for Electrical” and as stated herein.

1.7 SEQUENCING

- A. General Sequencing:
 - 1. Coordinate with other underground utilities and structures such that deeper equipment is installed first, where possible.
 - 2. Provide stakeout of all underground and in-ground equipment to identify conflicts prior to trenching or excavation.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the

following:

1. Concrete Manholes:
 - a. Penn-Cast Products, Inc.
 - b. A.C. Miller Concrete Products, Inc.
2. Concrete Handholes:
 - a. Penn-Cast Products, Inc.
 - b. A.C. Miller Concrete Products, Inc.
3. Composite Handholes:
 - a. Strongwell Quazite
 - b. Fiberlyte

2.2 BURIED UTILITY MARKER TAPE

- A. Non-biodegradable 3" wide plastic marker tape 12" below grade above every ductbank and buried conduit or cable. A system description (i.e. "ELECTRIC") shall appear continuously along its length. Tape shall meet ASTM D1712, "Standard Practice for Resistance of Plastics to Sulfide Staining" tests for color fastness. Tape shall contain a metallic core, which can be detected after burial in ground. Color coding per ANSI Z535.1.

- | | | |
|----|----------------|--------|
| 1. | Electric | Red |
| 2. | Communications | Orange |

2.3 UNDERGROUND DUCTBANKS

A. General:

1. Underground ductbanks shall be arrangements of single bore, PVC plastic conduits, concrete encased (where indicated) with steel rebar.

B. Materials:

1. Conduit and Fittings:
 - a. UL Listed, Type II, heavy-wall schedule 40 PVC.
 - b. Conduit and fittings shall be as specified in Section "Raceways and Boxes for Electrical Systems."
2. Concrete:
 - a. 3,000 psi test at 28 days.
 - b. Pea gravel aggregate for void-free duct penetration.
3. Reinforcing:
 - a. Deformed conforming to ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement," Grade 40 or Grade 60, minimum 1/2."
 - b. Coated rebar where exposed to earth, such as on ductbank stubouts.
4. Spacers:
 - a. Precast plastic, base and intermediate.
5. Joint Sealant:
 - a. Watertight as per by conduit manufacturer.
6. Cable Sealing Bushings:
 - a. OZ type CSB, with PVC coated discs, or equal.
7. Thruwall and Floor Seals:
 - a. OZ type "FSK" or "WSK", or equal.

2.4 DIRECT BURIED CONDUIT

A. For direct buried 600 volt electrical circuits:

1. PVC schedule 40 or PVC coated galvanized steel conduit, as indicated.
2. Conduit as specified in Section "Raceways & Boxes for Electrical Systems."

2.5 DIRECTIONAL BORED CONDUIT

A. For directional bore installation of 600 volt electrical circuits:

1. HDPE conduits.
2. Conduit as specified in Section "Raceways & Boxes for Electrical Systems."

2.6 IN-GROUND HANDHOLES

A. Construction:

1. Minimum size 18"x18"x24"D, unless noted otherwise.
2. Lightweight composite construction.
3. Sand/aggregate mixture bound with polymer and reinforced with woven glass strands.
4. Compressive strength 11,000 psi.
5. Flexural strength 7,500 psi.
6. Structural capacity of handhole and lid meeting AASHTO Tier 15 for loading (15,000 pound design load)
7. Heavy duty textured covers, color matched to installed locations:
 - a. Grass areas - Green.
 - b. Asphalt areas - Black.
 - c. Concrete areas - gray.
 - d. Brick or pavers - brick red.
 - e. Landscaped areas - brown or green.
8. All components sunlight resistant.
9. Threaded inserts and stainless steel bolts for covers.
10. Logo shall be integral with cover to indicate "ELECTRIC", "COMMUNICATION", "TELEPHONE", "SITE LIGHTING", etc.
11. Open bottom.
12. Quazite Compositelite or comparable product by Fiberlyte.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions:

1. Examine the site where the work is proposed.
2. Make allowances where proposed work shall cross, intersect or otherwise be affected by existing conditions.

3.2 PREPARATION

A. Utility Coordination:

1. Contact serving utility companies immediately upon award of contract. Do not install related equipment until fully coordinated with appropriate utilities.
2. Provide all construction schedules, dates of requested services, outage windows, equipment locations, etc. necessary for utility work.

3. Electric Utility:
 - a. Coordinate underground service entrance equipment and layout with Power Company prior to ordering or installing any service related equipment.
 4. Telephone Utility:
 - a. Coordinate incoming raceway with telephone utility company. Provide required conduit size as determined by telephone company.
 5. Cable television Utility:
 - a. Coordinate incoming raceway with cable television utility company. Provide required conduit size as determined by cable television company.
- B. Utility Stakeout:
1. On sites where public utility locating services are not provided, provide for services of an experienced underground utility locating company to locate and clearly mark all buried utilities and structures in the area of work.
 2. Provide initial stakeout of proposed locations of all equipment and systems, as specified in this section.
 3. After coordination with all other proposed utilities and existing conditions, provide final stakeout of proposed installations, for Owner approval.

3.3 ENCASED & DIRECT BURIED CONDUIT INSTALLATION

- A. General Requirements:
1. Install nonmetallic conduit and duct as indicated according to manufacturer's written instructions.
 2. Determine exact plans and profiles of underground conduit and ducts, based on field information and available as-built plans.
 3. Perform test pits at all utility crossings as shown on plans and available as-built drawings. Locate all shown utilities and structures, and make adjustments to proposed work.
 4. Verify location and inverts of existing utilities at proposed points of connection.
 5. Slope: Pitch ducts minimum of 4 inches per 100 feet (1:300) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between manholes or handholes to drain in both directions.
 6. Make all conduit joints and fittings watertight per to manufacturer's instructions.
 7. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- B. Curves and Bends: Use manufactured elbows with a minimum radius of 36" for stub-ups only at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet both horizontally and vertically at other locations and for all telecomm applications.
- C. Duct Entrances to Manholes: Space end bells approximately 10 inches on center for 5-inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

- D. Duct Connections: Provide connection of new ducts into existing manholes to prevent settling/cracking of ductbanks at manhole.
1. Properly compact the soil below the proposed ductbank connection at the manhole, as specified elsewhere in this section.
 2. Extend ductbank and form ductbank concrete into the interior face wall of the manhole in a single application. Do NOT stop ductbank outside manhole and grout remaining gaps around conduit.
 3. Provide a minimum of 8 LF of rebar in the ductbank from the interior manhole wall face into the buried ductbank.
 4. Provide duct end bells where exiting ductbank into manhole.
 5. Completely fill openings around entrance of duct lines with reinforced concrete and for a watertight installation.
- E. Duct Entrances to Handholes: Provide horizontal penetration of conduit into handholes. Utilize manufacturer's knockouts or field cut a punched hole opening for conduit. Gradually transition conduit from specified buried depth to knockout locations.
- F. Building Entrances: Transition from underground conduit to interior conduit 10 feet minimum inside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below.
1. Concrete-Encased Ducts: Install reinforcing in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
 2. Direct-Buried, Non-encased Duct Entering Non-waterproofed Walls: Install a Schedule 40 galvanized-steel pipe sleeve for each duct. Caulk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.
 3. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.
- G. Separation Between Direct-Buried, Non-encased Ducts: 3 inches minimum for like services, and 6 inches minimum between power and signal ducts.
- H. Concrete-Encased Nonmetallic Ducts:
1. Support on plastic separators coordinated with duct size and required duct spacing.
 2. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 3. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install: 1-inch reinforcing rod dowels extending 18 inches into the concrete on both sides of joint near the corners of the envelope.
 4. Reinforcing: Reinforce duct banks where they cross disturbed earth and where indicated.
 5. Forms: Use the walls of the trench to form the sidewalls of the duct bank where

the soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Clearances Between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts. Concrete envelope - 4 inches beyond surface of any conduit or duct.
- I. Stub-Ups: Use Schedule 40 PVC conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend conduit and terminate with end bell a minimum of 3" above pad.
- J. Sealing: Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi hydrostatic pressure.
- K. Pulling Cord: Install 200-pound-test nylon cord in ducts, including each and every spare.
- L. Buried Utility Marker Tape installed 12" below grade above every ductbank and buried conduit.
- M. For direct buried 600 volt electrical circuits:
 1. Burial depth as required by NEC Article 300-5 and Table 300-5.
 2. Minimum separation from other utilities of 18."
- N. Ductbank Burial Depth and Separations:
 1. Top of envelope below grade - minimum as follows:
 - a. 24 inches (600 volts and below)
 - b. 30 inches (above 600 volts)
 2. Separation from other buried utilities as follows:
 - a. All utilities: 24"
 - b. Uninsulated Steam: 48"
- O. Ductbank stubouts:
 1. Five feet out from manholes, minimum.
 2. Do not terminate under other ducts, concrete pads, pipes, etc. Extend stubout 5 feet past obstacle.
 3. Extend PVC ducts and rebar 18" past end of concrete to allow future tie in.
 4. Cap and seal all ducts to prevent water penetration.

3.4 DIRECTIONALLY BORED CONDUIT INSTALLATION

- A. General Requirements:
 1. Install nonmetallic HDPE duct as indicated according to manufacturer's written instructions.
 2. Locate all existing Determine underground conduit and ducts, based on field information, as-built plans, and utility locating contractor investigation.
 3. Perform test pits at all utility crossings as shown on plans and available as-built drawings, and as found in field. Locate all shown utilities and structures, and make adjustments to proposed work.
 4. Verify location and inverts of existing utilities at proposed points of connection by using vacuum excavation techniques.
 5. Directionally bored conduits shall be continuous for the entire installed length

between manholes, handholes, or connection to other rigid conduit systems.

- B. Entrances to Manholes: Space conduits approximately 10 inches on center for 5-inch ducts and varied proportionately for other duct sizes. Grout conduit ends into manhole or handhole walls from both sides to provide watertight entrances.
- C. Duct Entrances to Handholes: Provide horizontal penetration of conduit into handholes. Utilize manufacturer's knockouts or field cut a punched hole opening for conduit. Gradually transition conduit from specified buried depth to knockout locations.
- D. Separation Between Directionally Bored Ducts: Install all parallel runs of directionally bored conduits within 12 inches (horizontally) of each other. Length of each conduit shall not vary by more than 2% (longest to shortest conduit) over the length of the installation.
- E. Pulling Cord: Install 200-pound-test nylon cord in ducts, including each and every spare.
- F. Installation Depth and Separations For directionally bored 600 volt electrical circuits:
 - 1. Minimum burial depth as required by NEC Article 300-5 and Table 300-5, unless noted.
 - 2. Top of conduit below grade - minimum as follows:
 - a. 36 inches (600 volts and below)
 - 3. Separation from other buried utilities as follows:
 - a. All utilities: 24"
 - b. Uninsulated Steam: 48"

3.5 HANDHOLE INSTALLATION

- A. General:
 - 1. Install approximately where shown and where required for underground conduit runs exceeding 150LF. Exact location of each handhole shall be determined after careful consideration has been given to the location of other utilities, grading and paving.
 - 2. The location of each handhole shall be staked in field and approved before setting the handhole.
 - 3. Coordinate exact placement and elevation based on local grade, slope, other utilities, fences, roads and walkways, etc. which may affect location.
 - 4. Set level, and adjust for final, surrounding grade, such that lid is even with surrounding asphalt, concrete or soil.
- B. Conduit and Duct Connections:
 - 1. Sidewall conduit penetrations shall be sealed with grout or waterproof sealant.
 - 2. All conduit ends shall have bell fittings, or nylon or plastic bushings to prevent damage to wire insulation when pulling.
- C. Handhole Drainage:
 - 1. Set handholes on minimum 6-8" layer of clean, compacted gravel or stone for drainage (no dust).
 - 2. Provide filter fabric, placed between gravel and earth below handhole, and wrapped up along sides to prevent contamination of stone.

3.6 CONSTRUCTION

A. Excavation and Backfilling:

1. General:
 - a. Provide all excavating, backfill, compaction, seeding, sod and repair necessary to install underground electrical work.
 - b. Establish all lines and grades required for the proper location of the work and be responsible for the correctness thereof.
 - c. Verify location and check elevations of all existing utilities before starting work.
 - d. Keep banks of trenches as nearly vertical as possible, providing sheeting and shoring required for protection of work and safety of personnel.
 - e. Repair and/or replace any curbs, roads, walks, fences, utilities or structures disturbed as a result of the work in accordance with sections applicable to the work and to match the existing items.
 - f. Seed or sod all areas that are disturbed as a result of the work in accordance with sections applicable to the work.
 - g. Comply with all OSHA, federal, state and local requirements.
2. Excavation:
 - a. Perform excavation in whatever material encountered. Use customary methods suitable for the area and type of work.
 - b. Where excess excavation is made, back fill to required level with concrete.
 - c. Excavate to the lines or grades indicated on the drawings or established in the field.
 - d. Keep excavation drained and pumped out.
 - e. Cover all open trenches.
 - f. Install warning signs and flashers in accordance with applicable safety requirements.
 - g. Erect safety barriers of substantial material to keep persons from work area. Barriers shall be constructed where directed and shall support warning signs on all sides.
3. Backfilling:
 - a. Back fill to the required elevations and repair surfaces to their original condition.
 - b. Use back fill material that is free from rocks, roots, stumps, brush, rubbish or other objectionable matter.
 - c. Use no frozen material for backfilling and do not back fill on frozen material.
 - d. Tamp back fill in 6 inch layers.
 - e. Remove excess excavation not required or suitable for back fill.
 - f. Minimum compaction shall be as follows:
 - g. 95% below equipment pads, ductbanks, manholes, etc.
 - h. 95% for backfill below roads, walks or other paving and any vehicle or pedestrian traffic areas.
 - i. 90% for backfill in grass, or other non-paved areas.

B. Excavation and Backfilling:

1. Perform all excavating and backfilling necessary to install underground ductbanks, manholes, cables, etc., included in this Division of the work. Excavation and back fill shall be performed in accordance with the requirements - specified under Site Work Divisions.

C. Cutting and Patching:

1. Provide all cutting and patching necessary for the installation of the electrical work. Any damage done to the work already in place by reason of this work, shall be repaired at the Installer's expense by a qualified mechanic experienced in such work. Patching shall be uniform in appearance and shall match with the surrounding surface.

D. Grounding:

1. Refer to Section 26 05 26 "Grounding & Bonding For Electrical Systems" for specific requirements.

3.7 FIELD QUALITY CONTROL

A. General:

1. Inspect all installed work after completion of rough and final grading to ensure no damage has occurred to installed components.
2. Ensure final grading matches elevation of all installed components. Make adjustments, as required, to correct for settling, etc.
3. Verify all handhole and manhole lid logos match the contained systems.

3.8 ADJUSTING

A. General:

1. Make adjustments to manhole or handhole lid elevations to match final grades.
2. Where lids will more than 1 inch lower than surrounding final grade, concrete, or asphalt, make adjustments to structure elevation, collar height, grading or concrete/asphalt installation to provide matched elevations.

3.9 CLEANING

A. Manholes & Handholes:

1. Remove all wire clippings, tape, loose debris, etc. from inside of all manholes and handholes.

B. Ducts & Conduit:

1. After installation, but prior to installing cables, pull a mandrel sized $\frac{1}{4}$ " less than conduit ID to confirm no blockages or collapsed ducts.
2. Clean each installed conduit with a stiff brush to remove debris.

END OF SECTION

SECTION 26 0553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. The Work of this Section consists of furnishing and installation of identification for electrical materials, equipment, and installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. American Labelmark Co.
2. Calpico, Inc.
3. Cole-Flex Corp.
4. Emed Co., Inc.
5. George-Ingraham Corp.
6. Ideal Industries, Inc.
7. Kraftbilt
8. LEM Product, Inc.
9. Markal Corp.
10. National Band and Tag Co.
11. Panduit Corp.
12. Radar Engineers Div., EPIC Corp.
13. Seton Name Plate Co.
14. Standard Signs, Inc.
15. W.H. Brady, Co.

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Adhesive Marking Labels for Raceways and Metal-clad Cable: Pre-printed, flexible, self-adhesive labels with legend indication voltage and service (Emergency, Lighting, Power, Light, Power d.c., Air Conditioning, Communications, Control, Fire).
- B. Label Size: as follows
 1. Raceways 1-Inch and Smaller: 1-1/8 inches high by 4 inches long.
 2. Raceways Larger than 1-Inch: 1-1/8 inches high by 8 inches long.
- C. Color: Black legend on orange background.
- D. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- E. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Raceway and Cable Identification: Flexible acrylic bands sized to suit the raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the raceway or cable.

- F. Underground Line Marking Tape: Permanent, bright-colored, continuous-printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line blow.
- G. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- H. Aluminum, Wraparound, Cable Marker Bands: Bands cut from 0.014-inch thick, aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.
- I. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field-printed legends to suit the application. Orange background, except as otherwise indicated, with Eyelet for fastener.
- J. Aluminum-Faced Card Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inches thick, and laminated with moisture-resistant acrylic adhesive. Pre-print legend to suit the application, and punch for tie fastener
- K. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 inches by 2 inches by 19-gage.
- L. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 19 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.
- M. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- N. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location.
- O. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- P. Cable Ties: Fungus-inert, Self-extinguishing, One-piece, Self-locking nylon cable ties, 0.18-inch minimum width, 50 lb minimum tensile strength, and suitable for a temperature range from minus 50 deg F to 350 deg F. Provide ties in specified colors when used for

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- D. Conduit Identification:
- E. Identify high-voltage feeder conduits (over 600 v) by words "DANGER-HIGH VOLTAGE" in black letters 2 inches high, stenciled at 10-foot intervals over continuous painted orange background.
 - 1. The following areas shall be identified.
 - a. On entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
 - b. Prime Surfaces: For galvanized metal, use single-component acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy-duty acrylic resin block filler. For concrete surfaces, use clear alkali-resistant alkyd binder-type sealer.
 - c. Apply one intermediate and one finish coat of orange silicone alkyd enamel.
 - d. Apply primer and finish materials in accordance with manufacturer's instructions.
- F. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be pretensioned, snap-around colored plastic sleeves, colored adhesive marking tape, or a combination of the two. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color marking in contact, side by side. Install bands at changes in direction, at penetrations of wall and floors, and at 40-foot maximum intervals in straight runs. Apply the following colors:
 - 1. Fire Alarm System: Red
 - 2. Fire Suppression Supervisory and Control System: Red and Yellow
 - 3. Combined Fire Alarm and Watchmen's Report System: Red and Blue
 - 4. Watchmen's Report System: Blue
 - 5. Security System: Yellow
 - 6. Civil Defense System: Yellow
 - 7. Clock System: Green
 - 8. Mechanical and Electrical Supervisory System: Green and Blue
 - 9. Telephone System: Green and Yellow
- G. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indication system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or plasticized card stock tags at concealed boxes.
- H. Underground Electrical Line Identification: During trench backfilling, for exterior underground power, signal, communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
- I. Limit use of line markers to direct-burial cables.
- J. Install line marker for underground wiring, both direct buried and in raceway.

- K. Conductor Color Coding: Provide color-coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system to match the existing system.
- L. Use conductors with color factory-applied the entire length of the conductors except as follows:
1. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal point sand in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
 - b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
- M. Power Circuit Identification: Securely fasten identifying metal tags or aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb test monofilament line or one-piece self-locking nylon cable ties.
- N. Tag or label conductors as follows:
1. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
 2. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by means of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 3. Match identification marking with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- O. Apply warning, caution, and instruction signs and stencils as follows.
1. Install warning, caution, and instruction signs where required by NEC, where indicated, or where reasonable required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

P. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1/2 inch high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), white lettering in black field. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Motor starters
 - e. Pushbutton stations.
 - f. Power transfer equipment.
 - g. Contactors.
 - h. Dimmers.
 - i. Control devices.
 - j. Transformers.

Q. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

END OF SECTION

SECTION 26 2000

LOW VOLTAGE ELECTRICAL DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Switchboards.
2. Panelboards.
3. Enclosed and automatic circuit breakers.
4. Elevator Main Line Disconnects.
5. Contactors.
6. Disconnect switches.
7. Other distribution and/or control equipment.

B. Related Sections:

1. Section 26 05 00 "Common Work Results for Electrical" for concrete pads, bollards, labeling, and other general requirements.
2. Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables" for 600V conductors.
3. Section 26 05 26 "Grounding & Bonding for Electrical Systems" for grounding and bonding requirements.
4. Section 26 05 43 "Underground Ducts and Raceways For Electrical Systems" for coordination with connecting buried conduits, manholes, etc.

1.3 SUBMITTALS

A. Submittal Requirements of this section:

1. Enclosed and automatic circuit breakers.
2. Elevator Main Line Disconnects.
3. Pushbutton operators.
4. Safety Disconnect Switches.
5. Magnetic Contactors.
6. Panelboards.
7. Switchboards.

B. Product data: Include dimensions, construction, materials, performance data, etc.

C. Provide submittal data for each product type.

1. To verify specifications have been met/exceeded.
2. Independent laboratory test data where requested.
3. Clearly indicate or state all options, etc.:

D. Submit the following for each panelboard:

1. Manufacturer/cat. number.
2. Surface or flush mounting.
3. Main lugs or breaker ratings.
4. Integral surge protection devices (SPD).
5. Special lug configurations (double main lugs, feed through lugs, etc.).
6. Non-linear ratings, oversized neutrals, etc.
7. Specific listing of all installed breakers, spares and spaces, including installed position within panel or switchboard.
8. Interrupting rating of components and assemblies.
9. Bus materials and ratings.
10. Additional information to show compliance with specifications or drawings.

E. Submit the following for each switchboard:

1. Manufacturer/catalog number.
2. Elevation showing dimensions and sections.
3. 1-line diagram showing all components, connections, accessories, etc.
4. Incoming or metering sections.
5. Auxiliary wiring sections, as required.
6. Main lugs, switch, or breaker ratings.
7. Customer metering equipment.
8. Integral surge protection devices (SPD).
9. Specific listing of all installed breakers, spares and spaces, including installed position within panel or switchboard.
10. Interrupting rating of components and assemblies.
11. Bus materials and ratings.
12. Full scale log-log graph of fuse or breaker curves, when requested.
13. Complete information for all adjustable features, settings, etc. Include setting range and factory setting.
14. Ground fault protection system information including adjustable settings, ranges and factory settings.
15. Additional information to show compliance with specifications or drawings.

F. Product Test Reports: Certified copies of manufacturer's design and routine factory tests required by the referenced standards.

G. Closeout Submittals: Submit in accordance with the General Conditions and Division 01 requirements, Section 26 05 00 "Common Work Results for Electrical", and as follows:

1. All post-installation inspection checklists.
2. Installer's pre-startup checklist.
3. Post installation load test results.
4. Preventative maintenance schedule for each unit.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
3. Where equipment consists of multiple components, the entire assembly or product shall be UL Listed and Labeled, or Labeled by a testing organization

acceptable to the Authority Having Jurisdiction per the NEC.

B. Single-Source Responsibility:

1. The complete performance of assembled panelboards and/or switchboards, including all integral accessories, shall be the sole responsibility of the equipment supplier. It is the installer's responsibility to ensure that all factory and field installed accessories and loose components used in the system, meet these specifications, and perform up to the stated and tested standards.

C. Manufacturer/Vendor Requirements:

1. Coordinate the components of the system and their arrangements electrically and mechanically.
2. Manufacturer shall be experienced in manufacturing equipment of the types and capacities indicated that have a record of successful in-service performance for a minimum of 10 years.
3. Maintain, within 50 miles from site, a maintenance and service organization complete with parts inventory and repair facility. Service shall be available on a 24-hour basis.
4. Startup services and post installation tests, as specified.

D. Installer Qualifications:

1. Has installed a minimum of five (5) switchboards of similar size and conditions.
2. Has installed a minimum of three (3) switchboards manufactured by the proposed manufacturer.

E. Installation Quality: In accordance with recognized trade organizations and standards.

- | | | |
|-----|---------|--|
| 1. | ANSI | American National Standards Institute |
| 2. | ASME | American Society of Mechanical Engineers |
| 3. | ASTM | American Society for Testing and Materials |
| 4. | IEEE | Institute of Electrical and Electronics Engineers |
| 5. | IEEE C2 | "National Electrical Safety Code" |
| 6. | NEC | National Electrical Code |
| 7. | NECA | National Electrical Contractors Association "Standards of Installation". |
| 8. | NEMA | National Equipment Manufacturers Association |
| 9. | NETA | National Electrical Testing Association |
| 10. | NFPA | National Fire Protection Association |
| 11. | UL | Underwriter's Laboratories |

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Provide all transportation of equipment to site.
2. Provide for rigging needed for unloading, and setting large panels or switchboards into final position.

B. Storage and Protection:

1. Where unit is to be installed indoors, without enclosure, store in covered building or offsite to prevent exposure to weather, etc.
2. Apply temporary heat according to manufacturer's recommendations within

enclosure of each switchgear or switchboard section throughout periods during which equipment is not energized and is not under normal control of temperature and humidity.

1.6 SEQUENCING

A. General Sequencing:

1. Coordinate panelboard and switchboard installation with exterior and/or interior construction.
2. Provide for sub-grade or subslab roughins.
3. Coordinate construction of concrete pads with switchboard location.
4. Provide positioning and roughins such that required clearances are maintained after final installation.

1.7 WARRANTY

A. Provide standard manufacturer warranty for all equipment.

1. Warranty period shall be no less than one (1) year from initial startup.
2. Warranty shall cover the entire system, all components, performance, and installation integrity.
3. Warranty includes all parts, labor, and travel expenses, with no deductibles.
4. Installer shall complete and file all necessary documents to assure fulfillment of warranty requirements.
5. Deliver warranty documents to Owner in O & M manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Available Manufacturers: Subject to compliance with requirements, provide a system by the named "Basis of Design" manufacturer, or a comparable product of one of the other following named manufacturers:

1. Automatic Circuit Breakers:
 - a. Square D/Schneider Electric (basis of design)
 - b. General Electric
 - c. Siemens
 - d. Cutler-Hammer
2. Safety Disconnect Switches:
 - a. Square D/Schneider Electric (basis of design)
 - b. General Electric
 - c. Siemens
 - d. Cutler-Hammer
3. Contactors:
 - a. Square D/Schneider Electric (basis of design)
 - b. General Electric
 - c. Siemens
 - d. Cutler-Hammer
4. Panelboards:
 - a. Square D/Schneider Electric (basis of design)
 - b. General Electric
 - c. Siemens
 - d. Cutler-Hammer
5. Switchboards

- a. Square D/Schneider Electric (basis of design)
- b. General Electric
- c. Siemens
- d. Cutler-Hammer

2.2 AUTOMATIC CIRCUIT BREAKERS

- A. UL Listed, automatic circuit breakers for installation within panelboards and switchboards, or with enclosed cabinets and trim.
- B. Circuit breakers:
 - 1. Molded case, thermal magnetic, inverse time.
 - 2. Ratings as per drawings.
 - 3. Adjustable magnetic trip settings for breakers ≥ 225 amps.
 - 4. Accessories, as noted.
 - a. Mechanical kirk key interlocking.
 - b. Shunt trip.
 - c. Undervoltage trip.
 - d. Solid state trip for ground fault, long time pick-up and delay, short time pick-up and delay and instantaneous settings where indicated.
 - 5. Solid state electronic trip units for ground fault, long time pick-up and delay, short time pick-up and delay and instantaneous settings, where indicated. All breakers identified on drawings, or specified herein as having Electronic Trip Units (ETU) shall have the following features
 - a. Long Time Pickup and Delay
 - b. Short Time Pickup and Delay
 - c. Instantaneous
 - d. Ground Fault Pickup & Delay.
 - e. Zone Selective Interlocking
 - f. True RMS sensing
 - g. Adjustable setpoints via clearly marked dials
 - h. Clear lexan cover to seal adjustable settings from tampering or accidental contact.
 - i. Square D MicroLogic 6.0 Electronic Trip Units, or approved equal.
 - 6. In elevator machine rooms:
 - a. For elevator motor disconnects.
 - b. NEMA 12 enclosure with externally operable handle.
 - c. Handle padlockable only in the "OFF" position.
 - d. 120 VAC shunt trip for operation from heat detectors.
 - e. Auxiliary contacts to operate with main contacts (open when breaker is OFF). (Used for operation of battery lowering systems).
 - 7. UL Listed Service Entrance use, where required.
 - 8. Rated for 3 ϕ delta systems where applicable.
 - 9. Square D, or approved equal.
- C. Ground Fault Interrupter (GFI) branch breakers:
 - 1. Installed in branch circuit panelboards, where indicated.
 - 2. Single or two pole, per panel schedule.
 - 3. Class A protection, 6 mA trip for receptacle circuits.
 - 4. Equipment ground fault protection, 30mA trip for heat trace or other non-receptacle circuits.
- D. Arc Fault Interrupter (AFI) branch breakers:

1. Installed in branch circuit panelboards, where indicated.
2. Single or two pole, per panel schedule.
3. Arc fault sensing and circuit interruption, as required by NEC 210-12.

E. Enclosure and trim:

1. NEMA 1 enclosure, unless noted otherwise.
2. Deadfront cover.
3. Padlock provisions for locking breaker handle in ON or OFF position.
4. Rust-inhibiting phosphatized primer.
5. Factory finish paint (ANSI 61 gray).

2.3 ELEVATOR MAIN LINE DISCONNECTS

A. UL Listed, automatic circuit breakers or fusible disconnect switches for installation within elevator machine rooms, with enclosed cabinets and trim, serving as main line disconnect for elevator(s).

B. General:

1. UL Listed, dead-front device, providing overcurrent and short circuit protection of elevator motor.
2. Meets all requirements of NEC Article 620.
3. ANSI/ASME compliant for elevator main line disconnects.
4. Handle padlockable only in the "OFF" position.
5. Form C Auxiliary contacts to operate with main contacts (open when device is OFF). (Used for operation of battery lowering systems).
6. Provides for shunt trip voltage monitoring.

C. Circuit breaker Disconnects:

1. Molded case, thermal magnetic, inverse time.
2. Ratings as per drawings.
3. Adjustable magnetic trip settings for breakers \geq 225 amps.
4. NEMA 12 enclosure with externally operable handle.
5. 120 VAC shunt trip for operation via fire alarm relay (heat detector activated).
6. Square D, or approved equal.

2.4 ELEVATOR SHUNT TRIP TEST BUTTONS

A. Shunt trip test pushbutton stations for testing operation of shunt trip breakers serving elevator feeders. Provide one test button for each shunt trip breaker.

1. Pushbutton operators, contact blocks, & mounting base.
2. Rated 120V, momentary contacts.
3. Recessed mounting in finished areas.
4. 1" diameter, black pushbutton with metal ring guard.
5. Contact blocks with (1) N.O. and (1) N.C. rated 10 Amps.
6. Square D, or equal.

2.5 SAFETY DISCONNECT SWITCHES

A. Provide safety disconnect switches as shown on the drawings and where required by the National Electrical Code.

1. Horsepower rated for motor applications.
2. Solid neutral terminals where applicable.

3. Shielded phase conductor terminals.
4. Heavy duty type; 200kA Interrupting rating.
5. Enclosure ratings (unless indicated otherwise):
 - a. NEMA 1 for interior.
 - b. NEMA 3R for exterior, damp, or wet locations, on roof or on grade.
 - c. NEMA 4X Stainless Steel for food service and dishwashing areas.
6. Cover interlock to prevent operation with cover open.
7. Rejection feature (Class R) fuses, for fused units.
8. Externally operated, with all current carrying parts silver or tin plated. Side handle, quick-make, quick-break operation.
9. Padlockable, minimum of 2.
10. Disconnects for boilers shall comply with ASME CSD-1-2012, "Controls & Safety Devices for Automatically Fired Boilers."
11. Square D, or comparable product by previously named manufacturers.

2.6 LIGHTING CONTACTORS

- A. UL listed for tungsten, fluorescent and/or HID ballast lighting application, 600 VAC.
 1. Electrically operated, electrically held.
 2. 120V control power transformer with prim/sec fusing.
 3. 120 volt coil controlled as indicated.
 4. Number of poles per drawings.
 5. Minimum 30 Amp rating without derating for load.
 6. Enclosure: NEMA 1 for dry, indoor areas; NEMA 3R for damp, wet or exterior locations.
 7. HOA switch installed on enclosure door.
 8. Square D, or comparable product by previously named manufacturers.

2.7 PANELBOARDS

- A. UL Listed, factory assembled, circuit breaker panelboards with cabinets and trim, branch breakers.
- B. Enclosure and trim:
 1. NEMA 1 enclosure unless noted otherwise.
 2. Front-hinged door with lock.
 - a. All panels keyed alike.
 - b. Factory finish paint (ANSI 61 gray) on all surfaces.
 - c. Rust-inhibiting phosphatized primer.
 - d. Provide minimum (2) keys per lock.
 3. Galvanized back box.
 4. Recessed or surface mounting as indicated.
- C. Ratings:
 1. Fully rated interrupting ratings as per schedules.
 2. Loadcenters shall have 22k/10k series rating.
 3. Where Unit load center panel schedules have more than 24 spaces, loadcenters shall be 200 amp rated panel with 100 amp main and allowed main wire size of 4-250 copper. All others can have the 24 space with 125amp main
 4. UL Listed for Service Entrance, where applicable.
 - a. Provide neutral to ground bonding.
 5. Amp ratings as per drawing schedules.

- D. Construction:
1. Main lugs or breaker per drawing schedules.
 2. Double main lugs for connection of Type 1 SPD on line side of panels.
 3. Main breakers with additional line side lugs or termination lugs for connection of line side Type 1 SPD.
 4. All phase, neutral and ground bus bars shall be copper
 5. Interior equipment ground bar bonded to enclosure. Fully sized per NEC and UL, with sufficient lugs to accommodate all incoming and outgoing equipment grounding conductors.
 6. Bolt-on branch breakers, unless noted.
 - a. Use of connecting links, bars, etc. not permitted.
 7. Sequence (A-B-C) bussing.
 8. Double width panels for > 84 poles.
 - a. Separate back boxes and front cover for each section.
 - b. Poles equally divided between sections.
 9. Molded case, thermal magnetic branch and main breakers.
- E. Accessories:
1. Typewritten directory on panel door interior.
 2. Internal or external SPD protection, for panels indicated on drawing riser diagram.
- F. Panelboard types (Square D models, or comparable product by previously named manufacturers):
- | | | |
|----|---|--|
| 1. | 120/208V distribution ($\leq 600A$) | NQOD |
| 2. | 120/208V distribution ($> 600A$) | I-Line |
| 3. | 120/208V branch circuit ($\leq 600A$) | NQOD |
| 4. | 120/208V loadcenters | QO QO(with offset interior wide gutters) |

2.8 DISTRIBUTION PANELBOARD (800 A THROUGH 1200 A)

- A. Circuit breaker type distribution panelboard (drawings may indicate "switchboard") with circuit breaker branch circuit devices.
- B. Enclosure and trim:
1. NEMA 1, dead front enclosure, unless noted otherwise.
 2. Factory assembled frame and cover plates.
 3. Front-hinged door(s) with lock.
 - a. All panels keyed alike.
 - b. Provide minimum (2) keys per lock.
 4. Galvanized back box.
 5. Factory finish painted front cover (ANSI 61 gray).
 6. Recessed or surface mounting as indicated.
- C. Ratings:
1. Fully rated interrupting ratings as per schedules.
 2. UL Listed for Service Entrance, where applicable.
 - a. Provide neutral to ground bonding.
 3. Amp ratings as per drawing schedules.
- D. Construction:

1. Main lugs or breaker per drawing schedules.
2. All phase, neutral and ground bus bars shall be copper
3. Tin-plated bus at joints and connections.
4. Interior equipment ground bar bonded to enclosure.
5. 100% neutral bus.
6. Removable solid bar neutral link to permit disconnecting neutral bus from incoming neutral conductor on "Service Entrance" rated switchboards.
7. Plug-on bus connection breakers (I-Line).
 - a. Use of connecting links, bars, etc. not permitted.
 - b. Panel shall be capable of accepting branch breakers up to the frame size of the main lug or breaker rating.
8. Sequence (A-B-C) bussing.
9. Molded case, thermal magnetic branch and main breakers.
10. Adjustable magnetic trip for all breakers \geq 225 Amps.

E. Accessories:

1. Main Breaker with Ground Fault Protection.
2. Permanent ID plates for each breaker.

F. Square D I-Line, or comparable product by previously named manufacturers.

2.9 MAIN DISTRIBUTION SWITCHBOARDS

A. Main service entrance switchboard consisting of:

1. Single main device.
2. Distribution section(s).

B. Enclosure and trim:

1. NEMA 1, dead front enclosure, unless noted otherwise.
2. Factory assembled frame and cover plates rigidly welded and bolted together.
3. Factory shipping splits.
4. Rust-inhibiting phosphatized primer.
5. Factory finish paint (ANSI 49 gray).
6. Floor mounting on concrete slab, back to wall.
7. Front and left side access only.

C. Ratings:

1. Integrated, fully rated short circuit interrupting ratings as per schedules.
2. Bus braced for minimum 65,000 amp withstand rating.
3. Main breaker individually rated for a minimum interrupting rating of 65,000 amp asymmetrical, or as per schedule.
4. UL Listed for Service Entrance.
 - a. Provide neutral to ground bonding.
5. Additional ratings per plans.

D. Construction:

1. Phase and neutral bus bars shall be copper Plated bus.
2. Interior equipment ground bar bonded to enclosure.
3. 100% neutral bus.
4. Removable solid bar neutral link to permit disconnecting neutral bus from

- incoming neutral conductor for "Service Entrance" rating.
- 5. Sequence (A-B-C) bussing.
- 6. Outgoing top feeders.
- 7. Continuous steel base channels, full length.
- 8. Lifting eyes.

E. Main Lug Section:

- 1. Pre-drilled main bus connections and cable lugs for proposed incoming feeder sizes and quantities.
 - a. Suitable for copper or aluminum wiring.
 - b. Front accessible for initial installation and future testing access.

F. Main Breaker Section:

- 1. Full depth to match utility metering section.
- 2. Main insulated case breaker:
 - a. Fixed mount, insulated case circuit breaker.
 - b. 100% rated. (Maximum of 4000A)
 - c. Fully rated interrupting rating of 65,000 amps asymmetrical.
 - d. Solid state MicroLogic 6.0 electronic trip units.
 - e. Adjustable long time pickup & delay.
 - f. Adjustable short time pickup and delay.
 - g. Instantaneous settings.
 - h. Ground fault pickup & delay, when specified on plans.
 - i. Square D Type NW breaker, or comparable product by previously named switchboard manufacturers.
- 3. Permanent engraved phenolic ID plates.
 - a. MAIN SERVICE DISCONNECT

G. Customer Metering Panel:

- 1. True RMS metering to 31st harmonic.
- 2. Min/max readings for all meter parameters.
- 3. 1% accuracy class.
- 4. Metered parameters (minimum):
 - a. Ammeter, 3 phases & neutral
 - b. Voltmeter, L-L and L-N
 - c. Wattmeter
 - d. Varmeter
 - e. Va meter
 - f. Peak demand of above
 - g. Power factor
 - h. THD voltage
 - i. THD current
- 5. Square D PowerLogic CM-2050.

H. Distribution Section(s):

- 1. Provision for future extension into another distribution section.
- 2. Depth to match CT and Main Breaker sections.
- 3. 100% neutral bus.
- 4. Plug-on bus connection breakers (I-Line), bolted in place.
 - a. Use of connecting links, bars, etc. not permitted.
- 5. Sequence (A-B-C) bussing.
- 6. Molded case, thermal magnetic feeder breakers.

7. Group mounted feeder breakers.
 8. Adjustable magnetic trip for all breakers \geq 225 Amps.
 9. Double row, I-line distribution section with 117" total breaker mounting space available.
 10. Single row, I-line distribution section with 54" total breaker mounting space available.
 11. Permanent ID plates for each breaker and device.
 12. Continuous steel base channels, full length.
 13. Lifting eyes.
- I. Square D QED 2 Power Style Switchboard, or comparable product by previously named manufacturers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions: Examine the conditions under which the equipment shall be delivered, installed, and operated. Make all allowances required for operation, access and maintenance of the equipment, per Codes and manufacturers.

3.2 INSTALLATION

A. General Requirements:

1. Install all equipment, as indicated.
2. Maintain minimum working space at live parts according to manufacturer's written instructions and NEC.
3. Provide all required access space per NEC for controls, fuses and items requiring maintenance access.

B. Rough-in:

1. Rough-in all underslab or below grade conduits, ducts, etc. prior to setting panels, switchboards or other equipment in place.
2. Coordinate exact stubups with proposed manufacturer's equipment installation drawings and the work of other trades in this contract.
3. Roughin for all required circuits, controls, connections, etc. as required by proposed equipment, even if not explicitly indicated on plans.
4. Make minor adjustments to locations so as to maintain required front working clearances and clearance above and below per NEC.

C. Current Transformer Cabinet Installation:

1. Comply with all requirements of the serving utility company.
2. Mount CT cabinet securely to building wall or other solid surface.
3. Train incoming conduits to enter below cabinet footprint, unless noted otherwise.
4. Provide meter socket directly above CT cabinet, with short conduit section between for utility wiring (minimum of 1-1/4").

D. Panelboard Installation:

1. Comply with all requirements of NFPA 70, "National Electrical Code," Article 110, "Requirements for Electrical Installations," and Article 408, "Switchboards and Panelboards."

2. Install panels with sufficient support from structure to prevent movement.
3. Arrange for blocking in stud walls, as required.
4. For multiple section panels, provide all nipples, conduit and conductors to continue the full feeder size between sections. For sections not installed side by side, provide extended feeder length, as required in rigid metallic raceway.
5. Install conduits for recessed panels 2" back from front edge of panel.
6. Provide recessed panelboards with 1" empty conduits installed from the panelboard top to accessible ceiling space as below:

| TOTAL NUMBER OF SINGLE POLE SPARES AND SPACES | NUMBER OF 1" EMPTY CONDUITS |
|---|-----------------------------|
| 1 - 5 | Two |
| 6 - 10 | Four |
| 11 - 20 | Five |
| More than 21 | Ten |

7. Balance loading on all panelboards as closely as possible and to the satisfaction of the Architect, after all branch circuits are connected and loads energized.
8. Provide typed panelboard directories in each section to properly identify the circuits. Labeling shall include:
 - a. Type of circuit: Lights, Outlets, etc.
 - b. Room or rooms served, by room name or number.
 - c. Special equipment: Fire alarm, copier, etc.

E. Circuit Breaker Installation:

1. Install circuit breakers in panelboards, or with enclosure, as required.
2. GFI and AFI circuit breakers: Provide circuits with dedicated neutral conductors. Connect neutral through breaker at panelboards, per manufacturer's instructions.
3. Provide labels on all protected outlet coverplates to indicate "GFI PROTECTED" or "AFI PROTECTED", as applicable.

F. Elevator Main Line Circuit Breaker Installation:

1. Comply with all requirements of ANSI/ASME 17.1, "Elevators and Escalators."
2. Provide elevator fused safety switch for each elevator in Elevator Machine Room.
3. Install on EMR wall on strike side of door, per State Elevator Code requirements.
4. Provide phenolic ID label to clearly indicate which elevator the breaker supplies. Label as "ELEVATOR DISCONNECT, ELEVATOR."
5. For shunt trip breakers, install shunt trip test button immediately adjacent to elevator breaker in Elevator Machine Room.
 - a. Mounting height 48", directly adjacent to the elevator main line breaker.
6. Provide engraved red ID plate with white letters, at the shunt trip test button(s), to read: "ELEVATOR # SHUNT TRIP TEST"
7. Connect shunt trip wiring through fire alarm system relay or heat detectors, as indicated.
8. Provide all interconnecting wiring between pushbutton, fire alarm relay and shunt trip breaker.

G. Switchboard Installation:

1. Comply with all requirements of NFPA 70, "National Electrical Code," Article 110, "Requirements for Electrical Installations," and Article 408, "Switchboards and Panelboards."
2. Provide concrete foundation/equipment pad or housekeeping pad, per Section 26 05 00 "Common Work Results for Electrical".

3. Mount switchboard assembly, including all sections, on a concrete housekeeping pad.
4. Securely bolt switchboard frame sections to concrete pad.
5. Maintain 42" minimum clearance in front of all sections of switchboard.
6. On switchboards on exterior, below-grade walls, maintain a minimum of 4 inches of clearance between wall and rear of switchboard.
7. Provide engraved phenolic plastic nameplates, installed adjacent to each feeder breaker, to identify the load served.

3.3 CONSTRUCTION

A. Interface with Other Work:

1. Provide connections between proposed distribution equipment and other work of this contract:
 - a. Underground services and feeders.
 - b. Automatic transfer switches.

B. Grounding: Ground switchboards, panelboards, all metallic service and distribution equipment frames and enclosures per NEC and as specified in Section 26 05 26 "Grounding & Bonding For Electrical".

C. Connections: Tighten joints, connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torque requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," and 486B, "Wire Connectors for Use with Aluminum Conductors."

3.4 REPAIR/RESTORATION

- A. Restore all finishes, equipment, surfaces and/or grade to original condition, where affected by the work of this section.
- B. Comply with all requirements as specified in Section 26 05 00 "Common Work Results for Electrical".

3.5 FIELD QUALITY CONTROL

A. General:

1. Perform inspections and testing to ensure installation complies with Contract Documents, is operational within industry and manufacturer's tolerances, is adjusted to specific project parameters, and is suitable for energizing.
2. Acceptance Testing: Provide for acceptance testing of electrical equipment specified in this section, as follows, and as required in Section 26 05 00 "Common Work Results for Electrical".
3. Schedule tests and provide notification at least one week in advance of test commencement.
4. Provide a set of Contract Drawings to the testing agency.
5. Provide manufacturer's installation and testing instructions to the testing agency.
6. Provide complete shop drawing data on all equipment.
7. Provide written results of all tests. Include date, equipment ID, name of testing company and technician, and results of each individual test. Provide pass/fail indication for each test.

- B. Pre-Testing Inspections:
1. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Do not proceed with tests until deficiencies are corrected.
 2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, where not available, those of UL Standards 486A and 486B.
 3. All settings, as specified in this section, shall be properly set and verified prior to equipment testing.
- C. Acceptance Testing:
1. Switchboard and Panelboard Tests: After installing equipment, perform the following tests, at a minimum:
 - a. Perform insulation resistance tests, phase-phase and phase-ground for all buses and main breaker(s).
 - b. Perform continuity tests of all grounds, and bonded components.
 - c. Perform tests to confirm proper bonding of neutrals to ground, where intended.
 - d. Perform tests to confirm isolation of neutrals and grounds, except at intended locations.
 - e. Perform tests to confirm isolation of isolated grounds and equipment grounds, except at single intended location.
 - f. Perform overpotential tests per ANSI 37.20c.
 - g. Operation of auxiliary contacts and devices.
 - h. Operation of all gauges, displays and control equipment.
- D. Switchgear Tests: After installing switchgear and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
1. Procedures: Perform inspections and tests specified below. Report values that do not meet manufacturer's recommendations. Certify compliance with test parameters.
 - a. Perform insulation-resistance tests for all buses and breaker(s).
 - b. Perform continuity tests of all grounds, and bonded components.
 - c. Perform tests to confirm proper bonding of neutrals to ground, where intended.
 - d. Perform tests to confirm isolation of neutrals and grounds, except at intended locations.
 - e. Perform tests to confirm isolation of isolated grounds and equipment grounds, except at single intended location.
 - f. Perform insulation resistance tests, phase-phase and phase-ground.
 - g. Perform overpotential tests per ANSI 37.20c.
 - h. Operation of auxiliary contacts and devices.
 - i. Operation of all gauges, displays and control equipment.
- E. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Remove and replace malfunctioning components with new, and retest.
- F. Test Labeling: Upon satisfactory completion of tests for each transformer, attach a dated and signed "Satisfactory Test" label to the unit.
- G. Infrared Scanning: Perform an infrared scan of the specified equipment two (2) months

after Substantial Completion and at least one (1) month after owner occupancy.

1. Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform scan after switchboard has been energized for a minimum of 48 hours, and under full load for minimum of 60 minutes.
3. Prepare a certified report identifying equipment checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and rescanning observations after remedial action.
4. Provide color images on film or paper, showing each of the scanned objects. Image shall identify the equipment and object scanned, date, and shall include a color coded scale with temperature ratings for each color.
5. Provide a scan of the following equipment:
 - a. Main service entrance switchboard(s).
6. Scanning shall include the following items, as applicable:
 - a. Cable terminations at incoming (line side) lugs or main breaker and/or switch connections.
 - b. All main and vertical bus joints and connections.
 - c. All cable lug to bus connections.
 - d. All fuse holder clips for fusible switches or breakers.
 - e. Switch blade connections and joints.
 - f. Circuit breaker connections to bus and cable connections to circuit breaker lugs.
 - g. Fused switch connections to bus and cable connections to switch lugs.
 - h. Other current carrying components in the main current paths from line side connections to all outgoing cable or bus connections.

3.6 IDENTIFICATION

- A. Identify all distribution system components and wiring in accordance with Section 26 05 00 "Common Work Results For Electrical".
 1. Provide engraved nameplate for each individual switchboard, switchgear, panelboard, fusible switch, enclosed breaker, etc., which identifies the equipment per project nomenclature.
- B. Provide permanent warning signs on all electrical switchgear, switchboards, on electrical room doors, and on fenced yards containing such equipment. Warning signs shall be as specified in section 26 05 00 "Common Work Results for Electrical".

3.7 ADJUSTING

- A. General:
 1. Set all field adjustable parameters to those as specified.
 2. Set field adjustable pickup and time delay ranges of Ground Fault Systems and solid state breakers as indicated.

3.8 CLEANING

- A. General:
 1. Inspect interior and exterior of installed equipment and switchgear.
 2. Remove paint splatters and other spots, dirt, and debris.
 3. Touch up scratches and mars of finish to match original finish.

4. Remove protective films, etc. from all devices, controls, etc.
5. Remove debris, insulation and wire clippings, dirt, etc. from interior of all equipment.
6. Remove dirt, debris, etc. from top of all equipment.

3.9 DEMONSTRATION

- A. Owner Demonstrations: Provide a factory trained representative for each system and type of equipment, for the purpose of training owner's personnel:
1. Discuss proper operation, maintenance, and use of all equipment.
 2. Demonstrate periodic Owner testing and/or inspection of equipment.
 3. Demonstrate adjustment to Owner-accessible equipment and systems.
 4. Instructors shall be fully knowledgeable of the installed equipment and all components.
 5. Training shall be completed at the project site following Owner occupancy, at Owner's discretion.
 6. Schedule after all final tests, adjustments and Owner's acceptance.
 7. Training shall consist of a minimum of (4) hours of training and instruction, including use of delivered O&M manuals for each system or equipment.

END OF SECTION

SECTION 26 2416

PANEL BOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Work of this Section consists of furnishing and installing lighting and power panelboards and associated auxiliary equipment rated 600 V or less.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Siemens
 - 2. Square D
 - 3. Cutler Hammer/Eaton
 - 4. General Electric

2.2 PANELBOARDS, GENERAL REQUIREMENTS

- A. Over-Current Protective Devices (OCPDs): Provide type, rating and features as indicated. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.
- B. Enclosures: Cabinets, flush or surface-mounted as indicated. NEMA Type 1 enclosure, except where they following enclosure requirements are indicated.
 - 1. NEMA 3R: Rain tight.
 - 2. NEMA 12: Dust tight, drip-proof and resistant to oil and coolant seepage.
- C. Front: Secured to box with concealed trim clamps, except as indicated. Front for surface-mounted panels shall be same dimensions as box. Fronts for flush panels shall overlap box, except as otherwise specified.
- D. Directory Frame: Metal, mounted inside each panel door.
- E. Bus: Hard-drawn copper of 98% conductivity.
- F. Main and Neutral Lugs: Compression type.
- G. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.
- H. Service Equipment Approval: Listed for use as service equipment for panelboards having main service disconnect.
- I. Provision for Future Devices: Equip with mounting brackets, bus connections and necessary appurtenances, for the OCPD ampere ratings indicated for future installation of devices.

- J. Special Features: Provide the following features for panelboards as indicated:
 - 1. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
 - 2. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover.
 - 3. Sub-feed: OCPD or lug provision as indicated.
- K. Feed-through Lugs: Sized to accommodate feeders indicated.

2.3 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

- A. Branch OCPDs: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: In panel front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install panelboards and accessory items in accordance with NEMA PB1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 V or Less" and Manufacturer's written installation instructions.
- B. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289, "Application Guide for Ground Fault Interrupters."
- C. Mounting Heights: Top of trim 6'-2" above finished floor, except as indicated.
- D. Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush panel loads. Obtain approval before installing.
- E. Circuit Directory: Typed and reflective of final circuit changes required to balance panel loads. Obtain approval before installing.
- F. Install filter plates in unused spaces.
- G. Provision for Future Circuits at Flush Panelboards: Stub in four 1" empty conduits from panel into accessible ceiling space or space designated to be ceiling space in future. Stub four 1" empty conduits into raised floor space or below slab other than slabs on grade.
- H. Auxiliary Gutter: Install where a panel is tapped to a riser at an intermediate location.
- I. Wiring in Panel Gutters: Train conductors neatly in groups, bundle and wrap with wire ties after completion of load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs.

3.3 GROUNDING

- A. Connections: Make equipment-grounding connections for panelboards as indicated.

- B. Provide ground continuity to main electrical ground bus indicated.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals, including grounding connections, in accordance with Manufacturer's published torque-tightening values. Where Manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 CLEANING

- A. Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars of finish to match original finish.

3.6 COMMISSIONING

- A. Balancing Loads: after substantial completion, but not more than two months after final acceptance, conduct load-balancing measurements and circuit changes as follows:
 1. Perform measurements during period of normal working load as advised by the Owner.
 2. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as FAX machines and on-line data processing, computing, transmitting and receiving equipment.
 3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference between phase loads exceeding 20% at any one panelboard is not acceptable. Rebalance and recheck as required to meet this minimum request.

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 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. A/C switches.
2. Receptacles.
3. Connectors.
4. Device plates and covers.
5. Pin/sleeve connectors.

B. Related Sections:

1. Section 26 05 00 "Common Work Results for Electrical."
2. Section 26 05 33 "Raceways & Boxes for Electrical Systems" in which devices are to be installed.
3. Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables" for connecting wiring, cables and conductors.

1.3 SUBMITTALS

A. Submittal Requirements of this section:

1. A/C switches.
2. Receptacles.
3. Device plates and covers.

B. Product data for each device type:

1. Manufacturer's specifications, data sheets.
2. Wiring & connection diagrams, for dimmers, etc.
3. Capacity ratings, NEMA configurations, etc.
4. Information required indicating contract compliance.
5. Device color.
6. UL Listing.

- C. Closeout Submittals: Submit in accordance with the General Conditions and Division 01 requirements, and Section 26 05 00 "Common Work Results for Electrical>>".

1.4 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:

1. Deliver and store wiring devices and accessories according to manufacturers' instructions.

2. Do not store in unheated areas of high humidity, which might create corrosion or other deterioration.
3. Do not store in areas subject to high temperatures, which might cause deterioration or deformation of products.

1.5 SEQUENCING

A. General Sequencing:

1. Sequence installation of devices and equipment of this section such that damage to installed equipment is minimized.
2. Install device plates after all wall finishes have been completed.

B. Division 16 Sequencing, Coordination, and Integration:

1. Provide installation of wiring devices after supporting raceways and boxes are permanently installed.
2. Provide coordination of proposed wiring devices with actual cord/plug requirements of attached equipment.
3. Match wiring devices to plug connectors for Owner-furnished equipment.
4. Match wiring devices to plug connectors for equipment furnished under other Divisions.
5. Do not install permanently wired flexible connectors and associated cables/service cords until attached equipment is in place.

1.6 WARRANTY

- A. Provide warranty in accordance with the General Conditions, Division 01 requirements, Section 260500 "Common Work Results for Electrical" and as stated herein.

PART 2 - PRODUCTS

2.1 WIRING DEVICES - GENERAL

- A. General: Provide wiring device with cover plate for all devices as indicated on Drawings.

1. Switches:

- a. Single-pole, Grounded 15-amp, 120-volt toggle style switches, Pass and Seymour, Inc., Catalog No. 660WG (color to be selected by owner).
RESIDENTIAL UNITS ONLY
- b. 3-Way, Grounded 15-amp, 120-volt toggle style switches, Pass and Seymour, Inc., Catalog No. 6603WG RESIDENTIAL UNITS ONLY
- c. Single-pole, 20-amp, 120/277-volt toggle switches, Pass & Seymour (Legrand) Catalog No. PS20AC1-*(color to be selected by owner). Non-residential unit spaces only.
- d. 3-Way, 20-amp, 120/277-volt toggle switches, Pass & Seymour (Legrand) Catalog No. PS20AC3W. NON-RESIDENTIAL SPACES ONLY

2. Receptacles:

- a. Two-pole, three-wire, 15-amp, 125-volt duplex receptacle, Pass and Seymour, Inc., Catalog No. 3232-15W. RESIDENTIAL UNITS ONLY
- b. Two-pole, three-wire, 20-amp, 125-volt duplex receptacle with ground fault interrupter, Pass and Seymour, Inc., Catalog No. 2095 SW.
- c. Two-pole, three-wire, 20-amp, 125-volt duplex receptacle, Pass & Seymour (Legrand) Catalog No. CR20W.
- d. Tamper Resistant Duplex Receptacle (TR): Duplex NEMA 5-20R, 120-

volt, 20 amp, 3 wire, U-ground. Dual spring-loaded shutters to block single object insertion into either H or N openings. Nylon or lexan body. NEC Article 517-18 compliant. UL Listed as "Tamper Resistant" with identifying "TR" label. Pass & Seymour TR5362, or equal.

- e. Two-pole, three-wire, 20-amp 125-volt duplex receptacle for Emergency use, Pass & Seymour (Legrand) Cat. No. 26352-RED (Red). All emergency receptacles shall have the local panel and circuit number identified on the cover plate. Non-residential unit spaces only
- f. Tamper Resistant Duplex Receptacle (TR): Duplex NEMA 5-20R, 120-volt, 20 amp, 3 wire, U-ground. Dual spring-loaded shutters to block single object insertion into either H or N openings. Nylon or lexan body. NEC Article 517-18 compliant. UL Listed as "Tamper Resistant" with identifying "TR" label. Pass & Seymour TR5262, or equal.

B. Special Receptacles

- 1. Specification grade with lexan or nylon body and metal yokes. NEMA configurations and locking or straight-blade configurations, per drawings.
- 2. Pass & Seymour (Legrand), Arrow Hart, Hubbell, or equal.

C. Cover plates:

- 1. All device plates used on the project shall be the same manufacturer as the device installed.
- 2. Device plates shall be provided for each wiring device installed and shall be finished as follows.
 - a. All spaces (unless specified on drawings), outlets, switches and cover plates shall be "Smooth White" finish, steel type.
 - b. Commercial kitchen, mechanical room, etc., 3 oz. stainless steel cover plates.
- 3. Where gang combinations are required, the combinations shall be provided as single plate.
- 4. Where indicated on the Drawing, device plates are to be engraved, and letters shall be 3/16-inch block style with red fill. Devices connected to emergency power shall have "emergency" engraved on the cover plate. Emergency device plates may be red nylon without engraving, if allowed by local code. All emergency receptacles shall have the local emergency power panel and circuit number identified on the cover plate.
- 5. Telephone:
 - a. Telephone jack/ wall plates shall be Pass and Seymour TE1-W (white) or TE2-W (white). ILB's
- 6. Telecommunications:
 - a. Telecommunication jack wall plates shall be Pass & Seymour (Legrand) Single or Double Gang as required for snap-in jack modules. PSF1-(color to be selected by owner) for 1 snap-in module, PSF2-LA for 2 snap-in module, etc. CBs AND ERICKSON OFFICE SPACES IN ILBs
 - b. Telecommunication snap-in jack modules shall be Pass & Seymour (Legrand) RJ45, Category 5, 568A & 568B wiring PS58--(color to be selected by owner), unless noted otherwise on the drawings. CBs AND ERICKSON OFFICE SPACES IN ILBs
- 7. Cable Television:
 - a. Cable Television Wall Plates shall be Pass and Seymour CATV-* (color to be selected by owner)
- 8. Weatherproof:
 - a. Weatherproof cover plates shall be provided for all outlets exposed to the weather or as indicated on the drawings.

- 1) Provide Pass & Seymour (Legrand), Inc. Catalog No. 4600. Flush enclosure with anodized bronze finish for all public area at grade, on exterior balconies, and at roof terraces.
- 2) Provide Pass & Seymour (Legrand), Inc. Catalog No. 4500 Series for all non-public areas.

D. Digital Countdown Time Switches:

1. Ratings:
 - a. 120VAC, 800 watts.
 - b. Fluorescent.
2. 4 preset buttons for countdown period selection.
3. User selectable Timeout range from 5 minutes to 12 hours.
4. Adjustable in increments of 5 minutes (up to 1 hour) then 15 minutes (up to 12 hours).
5. Electroluminescent LDC display of time remaining.
6. User selectable audible signal every 5 seconds at 1 minutes prior to timeout.
7. User selectable visual flash of lights at 5 minutes and 1 minute prior to timeout.
8. Compatible with incandescent, fluorescent or inductive motor loads.
9. 5-year manufacturer's warranty.
10. Watt Stopper Model TS-400. *Color to match adjacent wiring devices, or per Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Requirements:

1. Install all equipment plumb and level.
2. Install devices tight to boxes, etc. such that no movement occurs during normal connecting and disconnecting procedures.
3. Install coverplates tight to surrounding surface. Coverplate shall not provide the only means of support for wiring devices.

B. Rough-in: Unless noted otherwise, the following mounting heights shall be used:

1. Wall receptacles: 18" AFF to center.
2. Countertop receptacles: 6" above counter to bottom of box.
3. Wall switches: 48" AFF to center.
4. Exterior receptacles: 24" above grade.
5. Roof receptacles: 24" above roof surface.
6. Washer/dryer outlets: 42" AFF to center.
7. Full-size frig/freezer: 42" AFF to center.

C. Ceiling Mounted Outlets:

1. Install all ceiling mounted receptacles as follows:
 - a. Flush mounted back box, with stainless steel coverplate installed tight to ceiling tile, plaster, or GWB ceiling.
 - b. Support back box independently of ceiling, with rigid support from structure.
 - c. Twistlock outlets, unless noted otherwise.

D. Identification:

1. Permanently identify all equipment in accordance with the project nomenclature.
 - a. Identify branch circuit panel and circuit number (i.e. RP-12).
 - b. General purpose receptacles – mark on back of coverplate with permanent marker.

3.2 CLEANING

A. General:

1. Clean all construction debris from within outlet boxes, prior to close-up.
2. Remove all paint, joint compound and other marks from devices and coverplates.

END OF SECTION

SECTION 26 2813

FUSES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Work of this Section includes furnishing and installing fuses rated 600 V and below and accessory items.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Bussman Div., Cooper Industries, Inc.
 2. General Electric Co.
 3. Gould, Inc.
 4. Littelfuse, Inc.
 5. Mersen

2.2 FUSES, GENERAL

- A. General: Provide fuses of types, classes and current ratings as indicated. Voltage ratings shall be consistent with the circuits on which used.
- B. Fuses for Direct Current Circuits: Marked for such use by the Manufacturer on the fuse label.

2.3 PLUG FUSES

- A. Standard: Comply with UL 198F "Plug Fuses."
- B. Type: Type S, dual-element, time delay.

2.4 CARTRIDGES FUSES

- A. General: Comply with ANSI/IEEE Standard, FU1, "Low Voltage Cartridge Fuses." Provide nonrenewable cartridge-type fuses except as indicated.
 1. Class J Fuses: Comply with UL 198C, "High-Interrupting Capacity Fuses, Current-Limiting Type."
 2. Class L Fuses: Comply with UL 198C, "High-Interrupting Capacity Fuses, Current-Limiting Type."
 3. Class RK 1 and RK5 Dual Element Time Delay Fuses: Comply with UL 198E, "Class R Fuses."
 4. Class RK 1 Fast-Acting Fuses: Comply with UL 198E, "Class R Fuses."

PART 3 - EXECUTION

3.1 APPLICATION OF FUSES

- A. General: Apply fuses as indicated and as follows.

- B. New General Purpose Fusible Switches: Apply the following class and types:
 - 1. 30-600 Amperes: Class RK 1, time delay.
 - 2. 601-1, 200 Amperes, Motor or Transformer Circuit: Class L, time delay.
 - 3. 601-1, 200 Amperes, Non-inductive Circuit: Class L, fast acting.
- C. Bolted Pressure Switches: Class L, time delay.
- D. Service Protectors: Class L, time delay.
- E. Fusible Switch Panelboards: Class RK 1, time delay.
- F. Combination Starters: Class RK 1, time delay.
- G. Switches in Switchboards: Apply the following classes and types:
 - 1. 60-600 Amperes: Class RK 1, time delay.
 - 2. 601 Amperes and Above: Class L, time delay.
- H. Existing General-Purpose Switches: Apply the following classes and types:
 - 1. 30-600 Amps: Class RK 1, time delay.
 - 2. 601-1, 200 Amps: Class L, time delay.

3.1 INSTALLATION

- A. Install fuses in fusible devices as indicated.

END OF SECTION

SECTION 26 2816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Work of this Section consists of furnishing and installing circuit and motor disconnects.

PART 2 - MANUFACTURERS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Appleton
 - 2. Challenger
 - 3. Crouse-Hinds Co.
 - 4. Cutler-Hammer Inc.
 - 5. Furnas Electric Co.
 - 6. General Electric Co.
 - 7. General Switch Corp.
 - 8. Square D Company.
 - 9. Westinghouse Electric Corp.

2.2 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features ratings and enclosures as indicated. Provide NEMA 1 enclosure except for outdoor switches and other indicated locations. Provide NEMA 3R enclosure with rain-tight hubs. For motor and motor starter disconnects, provide units with horsepower ratings suitable to the loads.
- B. Fusible Switches: Heavy-duty switches with fuses of classes and current ratings as indicated. See Section "FUSES" for specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable features suitable only for current limiting type fuses.
- C. Non-fusible Disconnects: Heavy-duty switches of classes and current ratings as indicated.
- D. Double-Throw Switches: Heavy-duty switches of classes and current ratings as indicated.
- E. Bolted Pressure Switches: Bolted pressure switches conforming to and listed under UL Standard 977, single- or double-throw arrangement as indicated. For fusible units provide fuses as indicated.
- F. Service Switches: Heavy-duty fusible switches. UL listed for use as service equipment under UL Standard 98 or 869.

- G. Switches for Classified (Hazardous) Locations: Heavy-duty switches, with UL labels and listings for hazardous location classifications in which installed.

2.3 ACCESSORIES

- A. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated.
- B. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
 - 1. Stainless Steel Type 304.
 - 2. Molded fiberglass reinforced plastic.
 - 3. Heavy cast aluminum.
- C. Captive Fuse Pullers: Provide built-in fuse pullers arranged to facilitate fuse removal.

PART 3 - EXECUTION

3.1 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS

- A. General: Provide circuit and motor disconnect switches as indicated and where required by the above Code. Comply with switch Manufacturer's printed installation instructions.

3.2 FIELD QUALITY CONTROL

- A. Testing: Subsequent to completion of installation of electrical disconnect switches energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

END OF SECTION

SECTION 26 5000

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. Lighting fixtures
2. Ballasts
3. Lamps
4. Photocells
5. Occupancy sensors

B. Related Sections:

1. Section 09 "Finishes" for coordination with mounting surfaces and materials.
2. Section 26 05 00 "Common Work Results for Electrical" for concrete pads, labeling, and other general requirements.
3. Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables" for 600V grounding and bonding conductors.
4. Section 26 05 26 "Grounding & Bonding for Electrical Systems" for grounding and bonding requirements.
5. Section 26 05 33 "Raceways and Boxes for Electrical Systems" for conduit and raceway connections.
6. Section 26 27 26 "Wiring Devices" for control switches, wallbox dimmers, etc.
7. Section 26 50 01 "Lighting Control Panelboards" for additional automatic lighting control requirements.

1.3 REFERENCES

A. ANSI

1. ANSI C78.1 American National Standard for Fluorescent Lamps- Rapid-Start Types -Dimensional and Electrical Characteristics
2. ANSI C82.4 Ballasts for High Intensity Discharge and Low-Pressure Sodium Lamps
3. ANSI C82.6 Reference Ballasts for High Intensity Discharge Lamps - Methods of Measurement
4. ANSI C82.11 High-Frequency Fluorescent Lamp Ballasts

1.4 SYSTEM DESCRIPTION

- A. Performance Requirements: Performance of the lighting fixtures and controls is based on the specified and/or indicated products. It is the full responsibility of the installer to ensure that any differences in products do not deviate from the intended design or performance.

1.5 SUBMITTALS

- A. Submittal Requirements of this section:
1. Individual lighting fixtures.
 2. Energy Star compliance for exit lights.
 3. Fluorescent ballasts.
 4. HID ballasts.
 5. Emergency battery inverter ballasts.
 6. Occupancy sensors.
 7. Lighting poles.
 8. Certain fixtures have been selected based not only on performance, but on appearance, finish, shape, etc. Any substitutions shall be equal in performance and construction, as well as in appearance, as judged by the Owner or Architect. Where no equals are available, as determined by the Architect, submit the specified fixture.
- B. Descriptive Data:
1. Manufacturer's specifications, data sheets.
 2. Catalog cuts.
 3. Dimensional drawings.
 4. Installation Instructions.
 5. Wiring & connection diagrams.
 6. Capacity ratings, performance curves.
 7. Information required to indicate contract compliance.
 8. Clearly indicate and/or mark options, etc.:
 - a. Manufacturer/cat. number.
 - b. Lamp type, number of lamps, etc.
 - c. HID ballast type, PF, data, etc.
 - d. Fluorescent ballast data.
 - e. Coefficient of Utilization (C.U.) charts.
 - f. Isofootcandle curves for exterior fixtures.
 - g. Construction data, materials, lens type, reflector material, housing, as applicable.
 - h. Warranty data.
 - i. Color charts, where applicable.
 - j. Fixture samples when requested.
- C. Wiring Diagrams:
1. Inverter ballasts, confirming the proposed wiring/control method.
 2. Occupancy sensors.
- D. Samples:
1. Provide fixture samples, when requested.
 2. Sample shall be identical to the proposed fixture in color, lamp, physical size, etc.
 3. Sample shall have a cord and plug, for connection to 120V, 20A wall receptacle.
- E. Closeout Submittals: Submit in accordance with the General Conditions and Division 1 requirements, Section , and as follows:

1. Provide relamping chart of all fixtures used on project and the corresponding lamp information.
2. Include lamp manufacturer, catalog number, color temperature and any special features (i.e. quartz restrike HID).
3. Control system programming, setup, and user controls.

1.6 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
 3. Where equipment consists of multiple components, the entire assembly or product shall be UL Listed and Labeled, or Labeled by a testing organization acceptable to the Authority Having Jurisdiction per the NEC.
- B. Single-Source Responsibility:
1. The complete performance of the assembled fixtures, mounts, poles, etc. including all accessories shall be the sole responsibility of the supplier. It is the installer's responsibility to ensure that all factory and field installed accessories and loose components used in the system, meet these specifications, and perform up to the stated and tested standards.
 2. Ensure that the complete fixture assembly complies with all individual component specifications, including ballasts, lamps, etc.
 3. Pole mounted fixtures: The manufacturer shall be responsible for the proper fit and performance of the fixture and pole, including attachment hardware, support arms, etc.
- C. Manufacturer/Vendor Requirements:
1. Manufacturer shall have a minimum 5-year record of fixture manufacturing and in service products of similar product.
 2. Furnish lighting fixtures indicated, complete with lamps, ballasts and mounting and/or suspension hardware.
 3. Furnish interior lighting fixtures with proper trim kits, framing kits, supports, etc.
 4. Furnish exterior fixtures mounted on the building with required backboxes to match mounting surfaces. Also include all pole mounted fixtures with pole standards.
 5. Drawing fixture schedule generally indicates required features and/or performance. Manufacturers' catalog numbers are noted for reference and may not include all suffixes and prefixes of required features. Provide fixtures with all the features of the base catalog number provided and all additional options indicated.
 6. Verify that proposed controls and other components which are to interface with the fixtures, ballasts, etc. are fully compatible with the fixture, ballast and lamp manufacturers' written instructions.
- D. Installer Qualifications:
1. Experienced in the installation and connection of all proposed fixture types, control components, and all other specified equipment.

E. Installation Quality: In accordance with recognized trade organizations and standards.

- | | | |
|-----|------|--|
| 1. | ANSI | American National Standards Institute |
| 2. | ASME | American Society of Mechanical Engineers |
| 3. | ASTM | American Society for Testing and Materials |
| 4. | IEEE | Institute of Electrical and Electronics Engineers |
| 5. | NEC | National Electrical Code |
| 6. | NECA | National Electrical Contractors Association "Standards of Installation." |
| 7. | NEMA | National Equipment Manufacturers Association |
| 8. | NETA | National Electrical Testing Association |
| 9. | NFPA | National Fire Protection Association |
| 10. | UL | Underwriter's Laboratories |

1.7 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Provide all transportation of unit(s) to site.
2. Provide for rigging needed for unloading poles, crossarm assemblies, and other large equipment, and setting into final position.

B. Storage and Protection:

1. Store all fixtures in original packaging, as recommended by manufacturer.
2. Store all fixtures in covered storage or building, out of the weather, until installation.
3. Protect fixtures from physical damage and deterioration due to excessive heat, moisture, etc.
4. Do not store electronic or sensitive components (i.e. occupancy sensors, control systems, etc.) in areas of high heat or humidity, which might create corrosion or other deterioration.
5. Provide covers for all aluminum blade louvered fixtures to prevent dirt, fingerprints, etc.
6. Store poles in horizontal position, on-grade with proper supports to prevent sagging and scratches.

1.8 PROJECT CONDITIONS

A. Fire Rated Ceilings: Fixtures shall be compatible with ceiling or ceiling assembly fire rating per Architectural drawings. Provide rated fixtures or tenting of light fixtures to maintain rating of ceiling. Refer to Architectural drawings and specifications for locations and rating requirements.

1.9 SEQUENCING

A. General Sequencing:

1. Coordinate layout and installation of fixtures with other installations.
2. Provide input to coordinated construction layout drawings to ensure fixtures are installed as designed. Revisions to locations and elevations from those indicated shall be made only after consulting the Engineer/Architect, as required to suit field conditions, and as approved by the Owner.
3. Coordinate actual fixture depths and locations with piping, ductwork, cable trays, bulkheads, and other ceiling mounted equipment, etc. prior to rough-in.

1.10 WARRANTY

- A. Provide standard manufacturer warranty on all equipment.
 - 1. Warranty period shall be no less than one (1) year from initial startup for all incandescent, fluorescent, and HID interior and exterior fixtures, ballasts and lamps.
 - 2. Warranty period shall be no less than one (1) year from initial startup for all control devices, occupancy sensors, photocells and associated components.
 - 3. Warranty period shall be no less than five (5) years from initial startup for all LED fixtures, drivers and components.
 - 4. Warranty shall cover the entire system, all components, performance, and installation integrity.
 - 5. Warranty shall include all parts, labor, and travel expenses, with no deductibles.
 - 6. Installer shall complete and file all necessary documents to assure fulfillment of warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, provide the named "Basis of Design" manufacturer and model ("Basis of Design" fixtures are indicated on the drawing fixture schedule), or a comparable product of one of the other following named manufacturers:
 - 1. Interior Lighting Fixtures:
 - a. Columbia Lighting
 - b. Lithonia Lighting
 - c. Cooper Industries
 - d. General Electric Co.
 - e. Prescolite
 - f. Lightolier
 - g. Kenall Lighting
 - h. New Star
 - i. Fine Lite
 - j. Guth Lighting
 - 2. Exterior Lighting Fixtures:
 - a. Lithonia Lighting
 - b. Cooper Industries
 - c. General Electric Co.
 - d. Prescolite
 - e. Kenall Lighting
 - f. New Star
 - g. Spaulding
 - 3. Vandal Resistant Lighting Fixtures:
 - a. Columbia Lighting
 - b. Lithonia Lighting
 - c. Cooper Industries
 - d. Kenall Lighting
 - e. New Star
 - f. Northern
 - 4. Ballasts:
 - a. Advance Ballast (Philips Lighting Electronics)
 - b. Magnetek
 - c. General Electric Co.

- d. Lightolier
- e. Lithonia
- f. Venture
- 5. Battery Inverter Ballasts:
 - a. Bodine (basis of design)
 - b. Prescolite
 - c. Lithonia
- 6. Lamps:
 - a. General Electric
 - b. Sylvania
 - c. Philips Lighting Electronics
 - d. Osram
 - e. Venture Lighting
- 7. Occupancy Sensors
 - a. Watt Stopper
 - b. Hubbell
 - c. Square D
- 8. Screw-In Achor Bases:
 - a. A.B. Chance Co.

2.2 GENERAL REQUIREMENTS

A. Listing/Labeling:

- 1. UL listed and labeled fixtures and wiring.
- 2. UL Damp or Wet location listed, as indicated or required.
- 3. UL hazardous area listed for Class, Division, and Group.

B. Mounting Accessories:

- 1. Fixture schedule generally indicates catalog number for lay-in tile ceilings.
- 2. Refer to Architectural drawings for ceiling types.
- 3. Provide fixture surface mounting kits, recessed framing kits, hardware, etc., as required.

2.3 CONSTRUCTION FEATURES

A. Fluorescent Fixtures:

- 1. Die formed steel housing of 22 gauge, minimum.
- 2. Post fabrication painting with baked white enamel, unless otherwise indicated. Pre-painted steel is not permitted.
- 3. Minimum reflectance of 87%.
- 4. Diffusers - 1/8" acrylic, unless noted.
- 5. Specification grade, unless noted.

B. Exterior Fixtures:

- 1. Cast aluminum housing, unless noted.
- 2. Dark bronze finish, or as selected by Architect.
- 3. UL Listed for Damp or Wet Location, as required.
- 4. Weatherproof gasketing.
- 5. Corrosion resistant hardware and materials.
- 6. Photocell as indicated.

C. Exit Light Fixtures:

1. All exit light fixtures shall comply with the US EPA's "Energy Star Program Requirements for Exit Signs" developed effective August 1, 2004.

2.4 FLUORESCENT BALLASTS

A. General Ballast requirements:

1. UL Listed.
2. CBM certified by ETL to ANSI C82.11 and C78.1.
3. Class "A" or greater sound rating.
4. Class P, auto reset, thermal protection.
5. Quick-disconnect electrical connectors for all double-ended fluorescent lamps and multi-wire circuit supplied fixtures, to meet requirements of NEC 410.73 (G) Disconnecting Means.

B. T8 Linear Electronic Fluorescent Ballasts:

1. Solid state, electronic ballasts
2. Programmed start with precise filament heating and starting voltage application.
3. Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail
4. Compatible with frequent on/off operations (i.e. occupancy sensors).
5. Series-Parallel lamp operation for 3- and 4-lamp ballasts.
6. Constant light output for voltage ranges 120V or 277V +10%.
7. Minimum starting temperature: 0°F
8. Audible noise above 16dB Ambient <2 db (A sound rating)
9. Total Harmonic Distortion (THD) <10%
10. Crest Factor <1.7
11. Input Power Factor >98% lagging
12. Ballast factor >0.88
13. Maximum Input watts (ANSI):
 - a. 1 lamp 28 watts
 - b. 2 lamps 55 watts
 - c. 3 lamps 83 watts
 - d. 4 lamps 110 watts
14. Single ballast for operation of 1-4 lamps.
15. Provide multiple ballasts where multi-level switching, or inverter ballasts are indicated (per drawings and/or schedule).
16. Low profile type.
17. Advance Optanium, MagneTek Triad, or approved equal.

C. Compact Fluorescent Lamp Ballasts:

1. Solid state, electronic ballasts
2. Programmed start with precise filament heating and starting voltage application.
3. Compatible with frequent on/off operations (i.e. occupancy sensors).
4. Series lamp operation for 2-lamp ballasts.
5. Constant light output for voltage ranges 120V or 277V +10%.
6. Minimum starting temperature: 0°F
7. Audible noise above 16dB Ambient <2 db (A sound rating)
8. Total Harmonic Distortion (THD) <10%
9. Crest Factor <1.7

10. Input Power Factor >98% lagging
11. Ballast factor >1.0
12. Single ballast for operation of 1 or 2 lamps.
13. Provide multiple ballasts where multi-level switching or inverter ballasts are indicated (per drawings and/or schedule).
14. Low profile type.
15. Ballast shall provide multiple voltage auto-sensing (108-305 V) and proper operation on either 120 or 277V. Advance SmartMate - Intellivolt, or equal.

D. Fluorescent Emergency Battery Inverter Ballasts:

1. For 48" linear and U-shaped fluorescent lamps:
 - a. Inverter ballasts for operation of (1) lamp.
 - b. Dual voltage 120/277 volt input.
 - c. Maintenance free, sealed nickel cadmium battery.
 - d. Charger and circuitry in UL Listed metal case.
 - e. Installed in, or on top of, fixture housing.
 - f. Battery shall provide 1100-1200 lumen initial light output, for 90 minutes.
 - g. Test button and charge indication LED on fixture.
 - h. 5-year full warranty.
 - i. Bodine B50 (basis of design).

2.5 HIGH INTENSITY DISCHARGE BALLASTS

A. General Requirement:

1. Compliance with the following ANSI standards:
 - a. ANSI C78 document, as applicable to the lamp type and wattage. Compliance for lamp current crest factor, starting currents, open circuit voltages and operating conditions.
2. Copper windings.
3. Outdoor ballasts suitable for starting and operation at -20°F (-40°F for HPS) throughout the input voltage range.
4. Maintain lamp watts within prescribed limits throughout rated lamp life, per ANSI (HPS lamps).
5. Lamp wattage regulation and dip tolerance shall be as defined by ANSI C82.4 and 82.6.
6. Hi-Pot test at 2,500 volts for one minute and a 10 kV transient insulation test as described in ANSI C82.4 and ANSI C82.6.

B. Metal Halide Ballasts:

1. General Requirements for All Metal Halide Ballasts:
 - a. Pulse-start ignitor.
 - b. Starting down to -40°F.
2. Pulse Start Constant Wattage Auto-regulator (CWA) type ballasts.
 - a. Maximum current crest factor of 1.6.
 - b. High (minimum 0.90) power factor.
 - c. Dip tolerance of 50 % of line voltage.
 - d. Lamp wattage regulation of ± 10 %.
 - e. Line Voltage regulations of ± 10 %.
 - f. Minimum start temperature: -20°F
 - g. Advance SuperCWA, or equal.
3. Quartz Re-Strike Controls:
 - a. Provide for fixtures indicated.
 - b. Quartz restrike shall be provided for"

- 1) Cold starts.
- 2) Hot restarts.
- c. Time delay circuitry.
- d. Soft start circuitry.

2.6 LAMPS:

A. T8 Linear Fluorescent Lamps (F32T8):

1. Reduced mercury content. Bulbs shall have passed the EPA Toxicity Characteristic Leaching Procedure (TCLP) tests.
2. Rated as non-hazardous waste, requiring no special disposal requirements.
3. 1" diameter (T8).
4. Medium bipin base.
5. Tri-phosphor coating.
6. CRI of 85 (minimum).
7. 20,000 hours rated life.
8. 3500K color Temperature, unless specified otherwise on plans.
9. General Electric Hi-Lumen, Philips, or Osram/Sylvania.

B. Compact Fluorescent Lamps:

1. Reduced mercury content. Bulbs shall have passed the EPA Toxicity Characteristic Leaching Procedure (TCLP) tests.
2. Rated as non-hazardous waste, requiring no special disposal requirements.
3. Double, quad, or triple tube, per fixture schedule.
4. 2 or 4-pin base, as required.
5. Tri-phosphor coating.
6. CRI of 82 (minimum).
7. 10,000 hours rated life.
8. 2700K color Temperature, unless specified otherwise on plans.
9. General Electric Biax, Philips, or Osram/Sylvania.

C. Metal Halide Lamps:

1. Medium or mogul base to match lamp wattage.
2. Universal burn position, unless required otherwise.
3. Clear lamp, unless noted otherwise.
4. CRI of 65 (minimum).
5. 10,000 (V), 6,000 (H) hours rated life, minimum.
6. 4000K color Temperature, unless specified otherwise on plans.
7. General Electric Multi-Vapor, Venture, Philips, or equal.

D. All fluorescent lamps and all HID lamps on the project shall be of the same manufacturer and color temperature to avoid variations in light and color between different manufacturers.

2.7 PHOTOCELLS

A. For single fixture control:

1. Integral with fixture where applicable.
2. Control only fixture where mounted.
3. Separately mounted photocells, not acceptable, unless otherwise indicated.

- B. For multiple fixture/contacter control:
1. Permanently wired & mounted in weatherproof box.
 2. 1/2" threaded fitting for knockout or threaded hub.
 3. Omni-directional via threaded fitting.
 4. UV treated translucent dome.
 5. Adjustable photocell shield.
 6. 2000W tungsten, 1800 VA ballast load.
 7. 120, 208 or 277 V, as required.
 8. Tork Model 2000, or equal.
- C. All Photocells:
1. Delayed action on and off to prevent false switching.
 2. Positive, snap action switching to prevent on-off cycling at dawn and dusk.
 3. Integral photocells by the fixture manufacturer, installed at the factory. Integral twist-lock type photocells are acceptable if installed as a permanent part of the fixture.

2.8 OCCUPANCY SENSORS

- A. Sensor requirements:
1. 120V or 277V operation, as applicable.
 2. Sensitivity adjustment with LED for calibration.
 3. Manual-On control of load(s) per 2012 IECC requirements.
 4. Adjustable sensitivity and time delay settings.
- B. Wall Switch PIR Sensor:
1. Passive infrared.
 2. 180° coverage.
 3. Coverage: 900 sq. ft. maximum, 300 sq. ft. for desktop activity.
 4. Maximum load (incand. or fluor); 800W @ 120V, 1200W @ 277V.
 5. 2 level, 36 segment fresnel lens.
 6. Adjustable 3-300 fc daylight sensor to maintain illumination (remains off when above set fc level).
 7. Button(s) for Manual-On of load(s) in compliance with 2012 IECC.
 8. Individual manual buttons for dual-circuit or bi-level controls, where indicated.
 9. WattStopper PW-100 (single circuit) or PW-200 (dual circuit) series.
- C. Wall Switch Ultrasonic Sensor:
1. Ultrasonic .
 2. 180° coverage.
 3. Coverage: 400 sq. ft. maximum, 225 sq. ft. for desktop activity.
 4. Maximum load (incand. or fluor); 800W @ 120V, 1200W @ 277V.
 5. 40kHz ultrasonic detection.
 6. Button(s) for Manual-On of load(s) in compliance with 2012 IECC.
 7. Individual manual buttons for dual-circuit or bi-level controls, where indicated.
 8. WattStopper UW-100 (single circuit) or UW-200 (dual circuit) series.
- D. Wall/Ceiling Mounted PIR Sensor:

1. Passive infrared.
2. 180° (wall) or 360° (ceiling) coverage.
3. Interchangeable lenses (patterns) for corridors.
4. Coverage: 1500 sq. ft. maximum, 500 sq. ft. for desktop activity.
5. Complete with power pack, relays.
6. Internal auxiliary contact for misc. functions.
7. Ganging of 1-3 sensors per power pack for large areas.
8. Adjustable 3-430 fc daylight sensor to maintain illumination (remains off when above set fc level).
9. WattStopper CI-100 (wall) or CI-200 (ceiling) series.

E. Ceiling Mounted Ultrasonic Sensor:

1. Ultrasonic, 25kHz +0.005%
2. 360° coverage.
3. Complete with power pack, relays.
4. 500, 1000, or 1500 sq. ft. coverage, as required.
5. Ganging of 1-3 sensors per power pack for large areas.
6. WattStopper W500A/1000A/1500A/2000H series.

F. Dual Technology Sensor:

1. PIR and Ultrasonic.
2. Universal wall/ceiling mounting bracket.
3. Complete with power pack, relays.
4. Internal auxiliary contact for misc. functions.
5. Ganging of 1-3 sensors per power pack for large areas.
6. Adjustable 3-430 fc daylight sensor to maintain illumination (remains off when above set fc level).
7. WattStopper DT-100L series.

2.9 POLE-BASE IN-LINE FUSE HOLDERS

A. In-line Fuse Holders to be installed in pole bases:

1. Insulated, weatherproof, in-line fuse holder.
2. Hydraulic crimp connectors, Burndy or equal.
3. Cold or heat shrink overall insulation.
4. Dual-element, time delay fuses - UL Class RK5 (1 per phase).
5. Suitable for submersion in water.
6. Accessible through handhole in pole base.

2.10 POWER-INSTALLED STEEL POLE FOUNDATIONS:

- A. Optional in lieu of poured in place concrete bases.
- B. Construction Features:
 1. Galvanized steel helical pole base foundations.
 2. Fixed length with bolt patterns to match pole base.
 3. 8" diameter shaft x 6 foot embedment length, or greater as recommended by manufacturer. 14" diameter helix.
 4. Provide mounting with top surface 1-2" above finished grade, per plans..
 5. Conduit/cable entrance slot minimum of 18" below grade.
- C. A.B. Chance Streetlight Foundations, CT112 series.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions: Examine the conditions under which the equipment shall be delivered, installed, and operated. Make all allowances required for operation, access and maintenance of the equipment, per Codes and manufacturers.

3.2 INSTALLATION

A. Fixture installation - General:

1. Support all fixtures independent of ceiling systems, ducts and piping.
2. Provide hangers from purlins, joists, beams, etc., for support of all boxes and fixtures.
3. Provide trapeze hanger supports for fixtures under ducts, large pipes, etc.
4. Galvanized steel for all hangers, channels, bolts, etc.
5. No fixtures shall be supported solely by grid or gypsum board ceilings.
6. Maintain required clearances around fixtures according to manufacturer's written instructions.

B. Recessed fixture frames:

1. Support recessed fixtures with galvanized tie wires, at two opposite corners of fixture.
2. Provide framing for all recessed fixtures.
3. Plaster frames for plaster or GWB ceilings.
4. Provide sloped ceiling adapters, where applicable.
5. Make electrical connections using flexible conduit, concealed above finished ceilings.

C. Surface Mounted fixture:

1. Install fixtures tight to ceiling or wall surface with no visible gaps.
2. Support fixture using rigid rods, channels, etc. Do not support from ceiling grid system or with wires.
3. Tighten attaching hardware evenly and per manufacturer's instructions to prevent warping or distortion of fixtures.
4. Provide recessed backbox to allow fixture mounting tight to surface.
5. Make electrical connections through rear of fixture, concealed as practicable.

D. Suspended fixture:

1. Provide hangers, rods, suspension cables, etc. for suspended fixtures, per drawings.
2. Install fixtures level and will all support rods or cables plumb.
3. Securely attach fixture to rigid supports, where applicable, to prevent wobble.
4. For continuous row fixtures, install rows straight and level. Provide supports at intervals, per manufacturer.
5. Make electrical connections from above, through top of fixture(s). Minimize visible cable or hollow rod wiring drops by using through wiring of continuous row fixtures, as permitted by manufacturer.

E. General Coordination:

1. Even, symmetrical spacing of fixtures.
2. Coordinate with diffusers, grilles and access panels in ceilings to establish a symmetrical pattern.
3. Drawings are general in nature and show approximate mounting locations of exterior lights. Coordinate during construction to center fixtures where applicable and coordinate with other wall mounted materials (downspouts, etc.).

F. Pole Mounted Fixtures:

1. Coordinate pole lights and foundations, anchor bolts and fixture orientations.
2. Properly aim all fixtures per the specified distribution patterns.
3. Determine exact pole base location prior to excavation or drilling.
4. Mark all pole locations and verify coordinate with all other trades prior to installation.
5. Repair damage to new or existing utilities, caused during installation, shall at no cost to Owner.

G. Occupancy Sensor Installation:

1. Install in ceiling or wall, per actual manufacturer's instructions. Drawings are not to be used for exact placement.
2. Infrared only sensors:
 - a. Maintain maximum distance from heating registers, convectors, unit heaters, and other moving hot air sources.
 - b. Do not aim sensing elements at open doors or windows.
3. Ultrasonic only sensors:
 - a. Do not aim sensing elements at open doors or windows.

3.3 CONSTRUCTION

- A. Grounding: Ground fixtures, housings, poles, and supporting equipment frames and enclosures per NEC and as specified in Section 26 05 26 "Grounding & Bonding for Electrical Systems."
- B. Connections: Tighten joints, connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torque requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors".

3.4 ADJUSTING

- A. General:
 - 1. Adjust aiming of all fixtures with adjustable optics or housings.
 - 2. Rotate downlight trims for proper orientation of louver blades or wall wash reflectors.

- B. Occupancy Sensor Adjustments:
 - 1. Provide masking or blocking of PIR sensors, as required to limit sensitivity to within the intended room/area only.
 - 2. Provide field adjustments to sensitivity and range, appropriate to the activity planned in the area, coverage area, etc.
 - 3. Provide shielding to limit sensitivity to nearby illumination sources, as required.
 - 4. Re-adjust any sensors for improved operation per Owner direction.
 - 5. Adjust footcandle level settings for sensors with daylight sensing.
 - 6. Set "Time Delay Off" adjustments, as follows:
 - a. Toilet Rooms: 15 minutes
 - b. Individual Offices: 15 minutes
 - c. Open Office Areas: 30 minutes
 - d. Conference Rooms: 15 minutes
 - e. Break/Lunch Rooms: 15 minutes
 - f. Utility or Storage Rms: 15 minutes
 - g. Other areas not listed: 30 minutes

- C. Photocell Sensor Adjustments:
 - 1. Where possible, set photocell "direction" toward North sky.
 - 2. Provide field adjustments to lighting sensitivity, appropriate to the activity planned in the area.
 - 3. Provide shielding to limit sensitivity to any nearby illumination sources, as required.
 - 4. Re-adjust any sensors for improved operation per Owner direction.

3.5 CLEANING

- A. General: Clean all fixtures after work of all trades is complete, and prior to turnover to Owner.
 - 1. Remove paint splatters and other spots, dirt, and debris.
 - 2. Touch up scratches and mars of finish to match original finish.
 - 3. Remove protective films, etc. from all devices, controls, etc.
 - 4. Remove all wire clippings, etc. from interior of fixtures.
 - 5. Adjust louvers, shielding, etc. for proper and consistent orientation.
 - 6. Thoroughly wipe clean all surfaces with degreaser/cleaner, suitable for material.
 - 7. Leave no visible dirt or fingerprints on lenses, louvers, housings, reflectors, lamps, etc.

3.6 DEMONSTRATION

- A. Owner Demonstrations: Provide a factory trained representative for each system and type of equipment, for the purpose of training owner's personnel:

1. Discuss proper operation, maintenance, and use of all equipment.
2. Demonstrate periodic Owner testing and/or inspection of equipment.
3. Demonstrate adjustment to Owner-accessible equipment and systems.
4. Instructors shall be fully knowledgeable of the installed equipment and all components.
5. Training shall be completed at the project site following Owner occupancy, at Owner's discretion.
6. Schedule after all final tests, adjustments and Owner's acceptance.
7. Training shall include use of delivered O&M manuals for each system or equipment.

B. Occupancy Sensor Demonstration:

1. Provide working demonstration for each type of sensor installed.
2. Explain function, delay settings, adjustments, etc.

END OF SECTION

SECTION 26 5001

LIGHTING CONTROL PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Lighting control panelboards using electrically operated relays.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. IP: Internet protocol.
- C. 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.
- D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- E. PC: Personal computer; sometimes plural as "PCs."
- F. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.

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 control modules, power distribution components, manual switches and plates, and conductors and cables.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each lighting control panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail bus configuration, current, and voltage ratings.
 - 3. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 5. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the network protocol.
- B. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Printout of software application and graphic screens.
 - 4. Device address list.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Provide all transportation of unit(s) to the site.
- B. Storage and Protection:
 - 1. Store panelboards in original packaging, as recommended by the manufacturer.
 - 2. Store panelboards in covered storage or building, out of the weather, until installation.
 - 3. Protect panelboards from physical damage and deterioration due to excessive heat, moisture, etc.
 - 4. Do not store panelboards in areas of high heat or humidity, which might create corrosion or other deterioration.

1.9 WARRANTY

- A. Provide standard manufacturer warranty for all equipment.
 - 1. Warranty period shall be no less than one (1) year from initial startup.

2. Warranty shall cover the entire system, all components, performance, and installation integrity.
3. Warranty includes all parts, labor, and travel expenses, with no deductibles.
4. Installer shall complete and file all necessary documents to assure fulfillment of warranty requirements.
5. Deliver warranty documents to Owner in O & M manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Lighting Control & Design - Glendale, CA, (800) 345-4448.

2.2 SYSTEM DESCRIPTION

- A. Lighting control system shall be digital and consist of a master lighting control panel (LCP) with up to 16 individual relays, remote LCPs with up to 16 individual relays in each panel, digital switches and digital interface cards. All system components shall connect in a "daisy chain" style configuration and be controlled via category 5 patch cable with RJ45 connectors, providing real-time two-way communication with each system component. Analog systems are not acceptable. All cables supplied by contractor.
- B. Relay panels shall be pre-wired, pre-assembled, preprogrammed and listed to UL 916 (normal) or ETL listed to UL924 (emergency). Panels shall be provided with dual voltage power supply. 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. Standard relays shall have normally closed latching (NCL) contacts UL listed 30A at 277VAC and 20A at 347VAC for ballast/HID and 20A tungsten at 120VAC with an 18,000A SCCR at 277VAC. 250,000 operations at 30A fully loaded. Optional 480VAC 2-pole relay shall be available.
- D. Relay panel electronics shall provide current visual status and control of each relay or zone. All system control electronics shall store programming in a non-volatile memory and provide 10-year battery backup for time of day.
- E. Lighting control system shall consist of master and remote panel(s) controlled by a 32-channel digital time clock (DTC) that controls and programs the entire lighting control system. The DTC shall supply all time functions and accept other inputs. The DTC shall accept control locally using built in button prompts and use of an 8 line 21-letter display, from a computer, modem, ethernet or internet. All commands shall be in plain english. Help pages shall display on the DTC screen.
- F. All switches shall communicate via RS 485, cat 5 patch cable with RJ45 connectors. Contact closure style switches are not acceptable. Any switch button function shall be able to be changed locally (at the DTC or a PC) or remotely, via modem, ethernet or internet. Refer to single line diagram for wiring details. Switches which cannot be programmed remotely shall not be acceptable.
- G. Photocell, exterior (PCO) or interior (PCI), shall provide readout on the DTC screen in number values analogous to foot-candles. Each photocell shall provide a minimum of 14 trigger points. Each trigger can be programmed to control any relay or zone. Each trigger shall be set through DTC, locally or remotely. Photocells that require the use of set screws or manual adjustments at the photocell control card shall not be acceptable.

- H. Lighting control system interfaces to include a dry contact input interface, BMS interface, BACnet interface, dimming system interface, ethernet/internet interface and an interface to smartbreaker panel boards. Verify and install only those interfaces indicated on the plans.
- I. Standard lighting control system software, pre-installed into the DTC, shall consist of and use standard graphical management software (GMS) pages. GMS software shall provide via local or remote pc a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone. Optional software that accepts job specific graphics shall be available. No exceptions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions: Examine the conditions under which the equipment shall be delivered, installed, and operated. Make all allowances required for operation, access and maintenance of the equipment, per Codes and manufacturers.

3.2 WIRING INSTALLATION

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 PANELBOARD INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Mounting Height: 72 inches to top of trim above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

3.4 IDENTIFICATION

- A. Create a directory to indicate loads served by each circuit; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are unacceptable.
- B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260500 "Common Work Results for Electrical."

3.5 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.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Confirm correct communication wiring, initiate communications between panels, and program the lighting control system according to approved zone configuration schedules, time-of-day schedules, and input override assignments.
 - 3. Contact LC&D at least 7 days before turnover of project. LC&D will remotely dial into the lighting control system, run diagnostics and confirm system programming. Contractor shall be available at the time of dial in to perform any corrections required by LC&D. Contractor is responsible for coordinating the installation of a dedicated telephone line or a shared phone line with a/b switch. Phone jack shall be mounted within 12" of master lighting control panel. Label jack with phone number. Contractor shall connect phone line from jack to master lighting control panel.
 - 4. Telephone factory dial-up support shall be available at no additional cost to the contractor or Owner both during and after the 3-year warranty period. Factory shall preprogram the lighting control system per plans and approved submittal. Manufacturer warrants that the DTC software can be upgraded and monitored remotely.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control modules.

END OF SECTION

SECTION 26 5100

INTERIOR LED 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. Interior solid-state luminaires that use LED technology.
 - 2. Lighting fixture supports.

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 IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture 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.

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. Lighting 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 luminaires will be attached.
 - 5. Initial access modules for acoustical tile, including size and locations.
 - 6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Ceiling-mounted projectors.
 - 7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of luminaire.
- F. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. Bulb shape complying with ANSI C79.1.
- F. Lamp base complying with **ANSI C81.61**.
- G. CRI and CCT as indicated on plans.
- H. Rated lamp life: minimum of 50,000 hours.
- I. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- J. Internal driver.
- K. Nominal Operating Voltage: as indicated on plans.
 - 1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- L. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized powder-coat painted finish.

2.3 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. 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.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized powder-coat 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.

2.4 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.

2.5 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. 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 fixture 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 inches (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 wire support 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. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 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 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

SECTION 26 5600

EXTERIOR LED 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.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaire.
 - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Photometric data and adjustment factors based on laboratory tests, complying with [IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project] [IES LM-79] [IES LM-80].
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
 7. Photoelectric relays.
 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
 2. Structural members to which luminaires will be attached.
 3. Underground utilities and structures.
 4. Existing underground utilities and structures.
 5. Above-grade utilities and structures.
 6. Existing above-grade utilities and structures.
 7. Building features.
 8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of the following:
1. Luminaire.
 2. Photoelectric relay.
- E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Source quality-control reports.
- G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- F. Mockups: For exterior luminaires, complete with power and control connections.
 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. CRI and CCT as indicated on plans.
- F. L70 lamp life of 50,000 hours.
- G. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- H. Internal driver.
- I. Nominal Operating Voltage: as indicated on plans.
- J. In-line Fusing: On the primary for each luminaire.

- K. Lamp Rating: Lamp marked for outdoor use.
- L. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- M. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 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. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Architect's sample of [manufacturer's standard] [custom] color.
 - c. Color: As selected by Architect from manufacturer's full range.

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, canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Support luminaires without causing deflection of finished surface.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
- G. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.
- I. Coordinate layout and installation of luminaires with other construction.
- J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 BOLLARD LUMINAIRE INSTALLATION:

- A. Align units for optimum directional alignment of light distribution.
 - 1. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

- A. Aim as indicated on Drawings.
- B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.6 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.10 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

**SECTION 31 2300
EARTHWORK**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General preparatory earthwork, including:
 - 1. Rough grading the site in preparation for building excavations and excavations for other site improvements.
- B. Structural earthwork related to support of building, including:
 - 1. Excavating for rammed aggregate piers supporting footings and slabs-on-grade.
 - 2. Filling, backfilling, and compacting for rammed aggregate piers supporting footings and slabs-on-grade.

1.02 SECTION EXCLUDES

- A. Section specifically excludes earthwork scope outside building structural support zone; see civil, landscape, and other Drawings, and associated specifications for earthwork requirements outside building structural support zone.
- B. The following earthwork requirements are indicated on civil or other Drawings, including but not limited to:
 - 1. Excavating for paving and site structures.
 - 2. Filling, backfilling, and compacting for paving and site structures.
 - 3. Trenching for utilities outside the building to utility main connections.
 - 4. Backfilling and compacting for utilities outside the building to utility main connections.

1.03 RELATED SECTIONS

- A. Section 00 3100 - Available Project Information: Geotechnical report; subsurface sampling and testing, findings and descriptions of subsurface materials encountered, and design recommendations.
- B. Section 31 6613.13 - Rammed Aggregate Piers: Aggregate piers for foundation and building slab support.

1.04 DEFINITIONS

- A. Finish Grade Elevations: Indicated on Drawings.
- B. Subgrade Elevations: Indicated on Drawings.

1.05 REFERENCE STANDARDS

- A. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate requirements for special foundations and load bearing elements specified in other Sections.

- B. Preinstallation Meeting: Conduct a preinstallation meeting minimum one week prior to the start of the work of this Section; require attendance by all affected installers, and Owner's geotechnical engineering consultant.
 - 1. Convene under general provisions of Section 01 7000.
 - 2. Discuss all earthwork requirements specified, and document any additional requirements or modified requirements received from Owner and Owner's geotechnical engineer which require a modification of the Contract.

1.07 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- C. Compaction density test reports.
- D. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. Locate stockpiles where designated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

- A. Soil materials, whether from sources on or off site must be approved by Owner's geotechnical engineer as suitable for intended use.

2.02 MATERIALS

- A. General Fill: Subsoil excavated on-site.
 - 1. Applications: All fill and backfill applications, unless otherwise specified.
 - 2. Graded and moisture conditioned as specified.
 - 3. Free of lumps larger than 3 inches, rocks larger than 3 inches.
 - 4. Free of organic matter, clay lumps, debris, and other deleterious matter.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect from damage above- and below-grade utilities that remain.

- C. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.
 - D. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.
 - E. Protect plants, lawns, and other features to remain as a portion of final landscaping.
- 3.03 ROUGH GRADING
- A. Do not reuse or replace wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
 - B. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
- 3.04 SOIL REMOVAL AND STOCKPILING
- A. Remove excavated material that is unsuitable for re-use from site.
 - B. Remove excess excavated material from site.
 - C. Stockpile excavated subsoil to be re-used on site; remove remainder from site.
 - D. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.
 - E. Use of explosives is not permitted.
- 3.05 EXCAVATING
- A. Excavate to accommodate new structures and construction operations.
 - B. Excavate subsoil required for building pad to accommodate installation of rammed aggregate piers, and to a point minimum 5 feet beyond the building line.
 - 1. Notify Architect of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
 - 2. Once building pad excavation has reached specified depth, request observation by Owner's geotechnical engineering consultant to evaluate suitability of exposed soils for subsequent backfilling. Owner's geotechnical engineering consultant may recommend further excavation or other remedial work, which will be provided in writing to Owner and Architect.
 - C. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored; comply with local, State and Federal regulations for excavation support.
 - D. Hand trim excavations. Remove loose matter.
 - E. Correct areas that are over-excavated and load-bearing surfaces that are disturbed to specified requirements.
 - F. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- 3.06 BACKFILLING
- A. Backfill to contours and elevations indicated using unfrozen materials.
 - B. Employ a placement method that does not disturb or damage other work.

- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Moisture Content: Maintain moisture content of fill and backfill materials, expressed as a percentage in relation to optimum moisture content, to attain required compaction density.
 - 1. Class GP, GW, GM, GC, SP, SW, SM, and SC Soils: Plus 2 percent to minus 2 percent.
 - 2. Class ML, MH, CL, and CH Soils: Plus 3 percent to minus zero (0) percent.
 - 3. Protect moisture content of prepared soil materials from moisture loss at all times.
- E. General Fill: Place and compact material in equal continuous layers not exceeding 8 inches loose depth.
- F. Slope grade away from building minimum 10 percent in the first 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- G. Correct areas that are over-excavated.
 - 1. All Areas: Use general fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.
- H. Reshape and re-compact fills subjected to vehicular traffic to specified requirements.

3.07 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. General: Comply with local jurisdiction requirements for earthwork bedding and fill work in public rights-of-way.
- B. The paragraphs below identify location, fill material to be used (identified from lower to upper fill type), and compacted thickness of each fill:
 - 1. At Exterior Side of Foundation Wall Backfill:
 - a. Use general fill.
 - b. Fill up to indicated finish grade elevations.

3.08 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
- B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Architect as to remedy.
- C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.09 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.
- C. Compaction density testing will be performed on compacted fill in accordance with ASTM D6938.
- D. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor").
- E. If tests indicate work does not meet specified requirements, remove work, replace and retest.

F. Frequency of Tests:

1. Conduct at least one field density test for foundation wall backfill at each lift, and not less than one set of tests for each 50 lineal feet of backfill.

3.10 PROTECTION

- A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

3.11 MAINTENANCE

- A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerance.
- C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.
- D. Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.12 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.
- B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.13 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

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SECTION 31 6613.13
RAMMED AGGREGATE PIERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shaft excavation; placement and compaction of aggregate, including piers supporting:
 - 1. Footings and foundations.
 - 2. Interior building slabs.
- B. Pier load testing.
- C. Design engineering of piers.

1.02 REFERENCE STANDARDS

- A. ASTM D1143/D1143M - Standard Test Methods for Deep Foundations Under Static Axial Compressive Load.
- B. ASTM D3966/D3966M - Standard Test Method for Deep Foundations Under Lateral Loads.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this Section; require attendance by all affected installers.
 - 1. Convene under general provisions of Section 01 7000.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate details and schedule of pier installation sequence.
- C. Design Data: Submit the following:
 - 1. Detailed design calculations.
 - 2. Description of quality control and field testing program.
 - 3. Documentation of design data sealed by Professional Structural Engineer licensed in Colorado.
- D. Field Quality Control Submittals: Submit daily.
 - 1. Pier location.
 - 2. Volume of aggregate.
 - 3. Installed pier depth.
 - 4. Number of lifts.
 - 5. Description of placement method and forces applied.
 - 6. Design elevation at top and bottom of pier.
 - 7. Actual, installed elevation at top and bottom of pier.
 - 8. Documentation of unusual or unexpected conditions encountered.
 - 9. Description of aggregate used.
- E. Designer's qualification statement.

- F. Project Record Documents: Record actual locations of piers, pier diameter, and pier length. Accurately record the following on project record documents:
 - 1. Sizes, lengths, and locations of piers and footing groups.
 - 2. Sequence of placement.
 - 3. Final base and top elevations.
 - 4. Deviation from indicated locations.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design under direct supervision of Professional Engineer experienced in design of this type of work and licensed in Colorado.
- B. Installer Qualifications: Company specializing in performing the work of this Section with minimum 5 years of documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- D. Monitor test pier placement and elevations under direct supervision of Professional Engineer experienced in design of this work and licensed in Colorado.

PART 2 PRODUCTS

2.01 RAMMED AGGREGATE PIERS

- A. Design Criteria: Design, or obtain qualified design, of rammed aggregate pier foundations as indicated in the Contract Documents.
 - 1. Determine system pressures and capacities required for pier installation and long-term performance of foundation system.
 - 2. Information necessary for design contained in the Contract Documents:
 - a. Locations of foundation elements.
 - b. Nominal design load for each foundation element, including dead load, live load and other loads required by building codes.
 - c. Subsurface geotechnical data may be obtained from Owner; also see Section 00 3100.

2.02 MATERIALS

- A. Aggregate: As required by pier designer to comply with specified requirements.

PART 3 EXECUTION

3.01 PREPARATION

- A. Use placement method that will not cause damage to adjacent existing structure.
- B. Notify adjacent and affected land owners and building occupants with 90 days notice before proceeding with work.
- C. Prepare to place piers from excavated working elevation. Do not begin installation until ground elevation at each pier location is at least 12 inches higher than indicated top bearing level of pier.

3.02 INSTALLATION

- A. Drill concentric and vertical pier shafts to diameters and depths indicated.
- B. Remove loose material from shaft sides and bottom. Maintain shafts free of water.
- C. Set top bearing levels of piers to elevations indicated.
- D. Prepare pier top to receive spread footings and interior building slabs.

3.03 TOLERANCES

- A. Maximum Variation From Vertical: 1 in 48.
- B. Maximum Variation From Design Top Elevation: 4 inches.
- C. Maximum Out-of-Position: 6 inches.

3.04 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01 4000 - Quality Requirements.
- B. Use same equipment and methods for test piers as production piers.
- C. Load test the following:
 - 1. Six indicator piers at locations as directed by Owner's geotechnical engineering consultant.
- D. Perform the following tests on each test pier:
 - 1. Static axial compression load test in accordance with ASTM D1143/D1143M.
 - 2. Lateral load test in accordance with ASTM D3966/D3966M.
 - 3. Subject piers to 1-3/4 times design load.
- E. Acceptable Permanent Set of Piers after Load Testing: 1/8 inch.
- F. Perform additional testing of other piers when tested piers do not comply with requirements.
- G. Witnessed and recorded by independent inspector.
- H. Compile all testing information and submit pier load test report prepared by independent inspector.

3.05 UNACCEPTABLE PIERS

- A. Unacceptable Piers: Piers that fail, are placed out of position, are below elevations, or are damaged.
- B. Remove unacceptable piers and replace with new piers that comply with specified requirements, as directed by Owner's geotechnical engineering consultant.

END OF SECTION

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