PROJECT MANUAL
FOR
WESTSIDE COMMUNITY LIBRARY
2932 South I-35 Frontage Road
New Braunfels, Texas 78130

OWNER: CITY OF NEW BRAUNFELS

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North Richland Hills, Texas 76180
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817.577.0896 fax

DATE: 21 August 2020 – Bid-Permit Set
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GEOTECHNICAL DATA

1.1 SUMMARY
   A. This document includes information pertaining to geotechnical data.

1.2 INVESTIGATION
   A. An investigation of subsurface soil conditions at the building site was authorized by the Owner, and was subsequently performed by Raba Kistner, Kleinfelder Project No. ANA19-062 -00, dated February 3, 2020.

1.3 REPORT
   A. The Geotechnical Investigation Report is for information only and is not a warranty of subsurface conditions.
   B. The Report is made available for information only and is not a Contract Document.
   C. The information contained in the Report represents design criteria, recommendations, and guidelines that were utilized as the basis of design for the engineering of the earthwork operations, paving design, and foundation design indicated in the Contract Documents. No changes in this design criteria will be considered or permitted. Where options are indicated, the options were considered by the respective design team members and implemented in the construction documents.

1.4 RESPONSIBILITY
   A. Bidders are expected to examine the site and subsurface investigation reports and then decide for themselves the character of the materials to be encountered.
   B. The Architect and Owner assume no responsibility for variations in subsoil conditions, quality, or stability, or for the presence, level, and extent of underground water.
   C. The Architect and Owner assume no responsibility for Bidder’s interpretation of data contained in the Report.

END OF DOCUMENT
Project No. ANA19-062-00
February 3, 2020

Mr. Joshua A. Niles
City of New Braunfels
550 Landa Street
New Braunfels, TX 78130

RE: Geotechnical Engineering Study
Westside Community Center Library Expansion
2932 South IH-35 Frontage Road
New Braunfels, Texas

Dear Mr. Niles:

RABA KISTNER Consultants Inc. (RKCI) is pleased to submit the report of our Geotechnical Engineering Study for the above-referenced project. This study was performed in accordance with RKCI Proposal No. PNA19-097-00, dated December 11, 2019. Authorization for this study was received by our firm on December 31, 2019. The purpose of this study was to drill borings within the proposed single-story library branch and ancillary parking areas, to perform laboratory testing to classify and characterize subsurface conditions, and to prepare an engineering report presenting foundation design and construction recommendations for the proposed library expansion, as well as to provide pavement design and construction guidelines.

The following report contains our design recommendations and considerations based on our current understanding of finished floor elevations, design tolerances and structural loads. There may be alternatives for value engineering of the foundation and pavement systems, and RKCI recommends that a meeting be held with the Owner and design team to evaluate these alternatives.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance with value engineering or on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

Richard T. Shimono, P.E.
Project Engineer

T. Ian Perez, P.E.
Associate

RTS/TIP/emd

Attachments

Copies Submitted: Above (1) – Email only

GEO100 04/09/2014
GEOTECHNICAL ENGINEERING STUDY

For

WESTSIDE COMMUNITY CENTER LIBRARY EXPANSION
2932 SOUTH IH-35 FRONTAGE ROAD
NEW BRAUNFELS, TEXAS

Prepared for

CITY OF NEW BRAUNFELS
New Braunfels, Texas

Prepared by

RABA KISTNER CONSULTANTS, INC.
New Braunfels, Texas

PROJECT NO. ANA19-062-00
February 3, 2020
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ATTACHMENTS

The following figures are attached and complete this report:

Boring Location Map ....................................................................................................................................................... Figure 1
Logs of Borings ............................................................................................................................................................... Figures 2 through 6
Key to Terms and Symbols .............................................................................................................................................. Figure 7
Results of Soil Analyses .................................................................................................................................................. Figure 8
Important Information About Your Geotechnical Engineering Report
INTRODUCTION

RABA KISTNER Consultants Inc. (RKCI) has completed the authorized subsurface exploration and foundation analysis for the proposed library expansion located at 2932 South IH-35 Frontage Road in New Braunfels, Texas, as illustrated on Figure 1. This report briefly describes the procedures utilized during this study and presents our findings along with our recommendations for foundation design and construction considerations, as well as for pavement design and construction guidelines.

PROJECT DESCRIPTION

The facilities being considered in this study include a single-story library addition and ancillary pavement areas located at 2932 South IH-35 Frontage Road in New Braunfels, Texas. The proposed library branch is anticipated to be 8,800 sq ft in plan dimension. Column loads are anticipated to be on the order of 5 to 100 kips.

It is our understanding that at the time of this study, site grading plans were not yet available. We understand that the proposed structure will adjoin the existing Westside Community Center building. We further understand that swell/settlement should be limited to 3/4 in.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of south/central Texas and for the use of City of New Braunfels (CLIENT) and its representatives for design purposes. This report may not contain sufficient information for purposes of other parties or other uses. This report is not intended for use in determining construction means and methods. The attachments and report text should not be used separately.

The recommendations submitted in this report are based on the data obtained from 5 borings drilled at this site, our understanding of the project information provided to us, and the assumption that site grading will result in only minor changes in the existing topography. If the project information described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our recommendations.

This report may not reflect the actual variations of the subsurface conditions across the site. This is particularly true of this site where the potential presence of solution cavities and/or voids that may not have been encountered in our test borings. The nature and extent of variations across the site may not become evident until construction commences. The construction process itself may also alter subsurface conditions. If variations appear evident at the time of construction, it may be necessary to reevaluate our recommendations after performing on-site observations and tests to establish the engineering impact of the variations.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.
If final grade elevations are significantly different from existing grades (more than plus or minus 1 ft), our office should be informed about these changes. If needed and/or if desired, we will reexamine our analyses and make supplemental recommendations.

**BORINGS AND LABORATORY TESTS**

Subsurface conditions at the site were evaluated by 5 borings drilled at the locations shown on the Boring Location Map, Figure 1. These locations are approximate and distances were measured using a hand-held, recreational-grade GPS locator. The borings were drilled to depths ranging from 5 ft below the existing ground surface in the pavement areas, and 50 ft below the existing ground surface in the area of the building pad. Drilling operations were conducted using a truck-mounted drilling rig. During drilling operations, 32 split spoon samples (with Standard Penetration Testing) were collected.

Each sample was visually classified in the laboratory by a member of our geotechnical engineering staff. The geotechnical engineering properties of the strata were evaluated by the following tests:

<table>
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<th>Type of Test</th>
<th>Number Conducted</th>
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<tr>
<td>Natural Moisture Content</td>
<td>32</td>
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<tr>
<td>Atterberg Limits</td>
<td>8</td>
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<tr>
<td>Percent Passing a No. 200 Sieve</td>
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The results of all laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Figures 2 through 6. A key to classification terms and symbols used on the logs is presented on Figure 7. The results of the laboratory and field testing are also tabulated on Figure 8 for ease of reference.

Standard Penetration Test results are noted as “blows per ft” on the boring logs and Figure 8, where “blows per ft” refers to the number of blows by a falling hammer required for 1 ft of penetration into the soil/weak rock (N-value). Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 in. (seating blows), refusal “ref” for 6 in. or less will be noted on the boring logs and on Figure 8.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

**GENERAL SITE CONDITIONS**

**SITE DESCRIPTION**

The project site is a partially developed tract of land located north adjacent to the existing Westside Community Center, southwest of the intersection of South Krueger Avenue and IH-35 Frontage Road in New Braunfels, Texas. The proposed building footprint is primarily grass-covered, but a portion is currently occupied by a one-story building. Proposed new pavement areas are partially paved with existing asphalt pavement, partially grass-covered, and partially occupied by one-story structures and planter beds.
There are likely to be a significant number of existing utilities associated with the existing community center and adjacent one-story building. The presence of buried utilities should be anticipated during construction.

**GEOLOGY**

A review of the *Geologic Atlas of Texas, San Antonio Sheet*, indicates that this site is naturally underlain by fluvial terrace deposits, which are stream bed deposits typically consisting of clays, sands, silts, and gravels. Such deposits can contain point bars, cutbanks, oxbows, and abandoned channel segments associated with variations in stream bed activity. As a result, soil profiles in terrace deposit areas may vary greatly over relatively short distances. Key geotechnical engineering concerns for development supported on this formation are the expansive nature of the clays, the consistency or relative density of the deposits, and the absence/presence as well as thickness of potentially water-bearing gravels.

**SEISMIC CONSIDERATIONS**

On the basis of the soil borings conducted for this investigation, the upper 100 feet of soil may be characterized as very dense soil and soft rock, and a Class C Site Class Definition (Chapter 20 of ASCE 7) has been assigned to this site.

On the basis of the Structural Engineers Association of California/Office of Statewide Health Planning and Development (SEAOC/OSHPD) website\(^1\) which utilizes the International Building Code (IBC) and U.S. Seismic Design Maps to develop seismic design parameters, the following seismic considerations are associated with this site.

<table>
<thead>
<tr>
<th>(S_s)</th>
<th>(S_{ms})</th>
<th>(S_{0s})</th>
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<tbody>
<tr>
<td>0.074g</td>
<td>0.089g</td>
<td>0.059g</td>
</tr>
<tr>
<td>0.031g</td>
<td>0.053g</td>
<td>0.035g</td>
</tr>
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</table>

Based on the parameters listed above as well as Tables 1613.3.5(1) and 1613.3.5(2) of the 2015 IBC, the Seismic Design Category for both short period and 1 second response accelerations is A. As part of the assumptions required to complete the calculations, a Risk Category of “I, II, or III” was selected.

**STRATIGRAPHY**

The subsurface stratigraphy at this site can be described by three generalized strata. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. The boring logs should be consulted for more specific stratigraphic information. The lines designating the interfaces between strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual.

---

\(^1\) [https://seismicmaps.org](https://seismicmaps.org)
In general, subsurface conditions consisted of dark brown fat clay overlying tan and gray to tan, fat clay to approximate depths on the order of 43 ft, below which hard, gray fat clay/clayshale was encountered. Gypsum deposits were observed in soil samples below 20 to 30 ft in our borings.

GROUNDWATER

Groundwater was not observed in the borings either during or immediately upon completion of the drilling operations. All borings remained dry during the field exploration phase. However, it is possible for groundwater to exist beneath this site at shallow depths on a transient basis, particularly following periods of precipitation. Fluctuations in groundwater levels occur due to variation in rainfall and surface water run-off. The construction process itself may also cause variations in the groundwater level.

FOUNDATION ANALYSIS

EXPANSIVE SOIL-RELATED MOVEMENTS

The anticipated ground movements due to swelling of the underlying soils at the site were estimated for slab-on-grade construction using the empirical procedure, Texas Department of Transportation (TxDOT) Tex-124-E, Method for Determining the Potential Vertical Rise (PVR). PVR values ranging from 5 to 5-3/4 in. were estimated for the stratigraphic conditions encountered in our borings. A surcharge load of 1 psi (concrete slab and sand layer), an active zone of 15 ft, and dry moisture conditions were assumed in estimating the above PVR values.

The TxDOT method of estimating expansive soil-related movements is based on empirical correlations utilizing the measured plasticity indices and assuming typical seasonal fluctuations in moisture content. If desired, other methods of estimating expansive soil-related movements are available, such as estimations based on swell tests and/or soil-suction analyses. However, the performance of these tests and the detailed analysis of expansive soil-related movements were beyond the scope of the current study. It should also be noted that actual movements can exceed the calculated PVR values due to isolated changes in moisture content (such as due to leaks, landscape watering...,) or if water seeps into the soils to greater depths than the assumed active zone depth due to deep trenching or excavations.

OVEREXCAVATION AND SELECT FILL REPLACEMENT

To reduce expansive soil-related movements in at-grade construction, a portion of the upper highly expansive subgrade clays in the building area can be removed by overexcavating and backfilling with a suitable select fill material. PVR values have been estimated for overexcavation and select fill replacement to various depths below the existing ground surface and are summarized in the table below. Recommendations for the selection and placement of select backfill materials are addressed in a subsequent section of this report.
To maintain the estimated PVR values, subsequent fill placed in the building area should consist of select fill material in accordance with the Select Fill section of this report.

Due to the depth of overexcavation and select fill replacement required to reduce the expansive soil-related movements, a suspended foundation system should be considered. Alternatively, the Tella-Firma foundation system may be considered, which is a cast-on-ground foundation system that results in a suspended foundation system supported on helical piers and requires little to no ground improvement. The Tella Firma foundation system is a proprietary system, but if selected to support the proposed facility, RKCI should be retained to determine the design parameters required to facilitate the evaluation.

Recommendations for ground supported and suspended foundation systems are provided herein. For a ground supported foundation system, cement stabilized fill may be utilized in the lower half of the proposed overexcavation and select fill replacement depth to reduce the impact of shrinkage settlement, as discussed in subsequent sections of this report.

**Drainage Considerations**  When overexcavation and select fill replacement is selected as a method to reduce the potential for expansive soil-related movements at any site, considerations of surface and subsurface drainage may be crucial to construction and adequate foundation performance of the soil-supported structures. Filling an excavation in relatively impervious plastic clays with relatively pervious select fill material creates a “bathtub” beneath the structure, which can result in ponding or trapped water within the fill unless good surface and subsurface drainage is provided.

Water entering the fill surface during construction or entering the fill exposed beyond the building lines after construction may create problems with fill moisture control during compaction and increased access for moisture to the underlying expansive clays both during and after construction.

Several surface and subsurface drainage design features and construction precautions can be used to limit problems associated with fill moisture. These features and precautions may include but are not limited to the following:

- Installing berms or swales on the uphill side of the construction area to divert surface runoff away from the excavation/fill area during construction;
• Sloping of the top of the subgrade with a minimum downward slope of 1.5 percent out to the base of a dewatering trench located beyond the building perimeter;
• Sloping the surface of the fill during construction to promote runoff of rain water to drainage features until the final lift is placed;
• Sloping of a final, well maintained, impervious clay or pavement surface (downward away from the building) over the select fill material and any perimeter drain extending beyond the building lines, with a minimum gradient of 6 in. in 5 ft;
• Constructing final surface drainage patterns to prevent ponding and limit surface water infiltration at and around the building perimeter;
• Locating the water-bearing utilities, roof drainage outlets and irrigation spray heads outside of the select fill and perimeter drain boundaries; and
• Raising the elevation of the ground level floor slab.

Details relative to the extent and implementation of these considerations must be evaluated on a project-specific basis by all members of the project design team. Many variables that influence fill drainage considerations may depend on factors that are not fully developed in the early stages of design. For this reason, drainage of the fill should be given consideration at the earliest possible stages of the project.

FOUNDATION RECOMMENDATIONS

SITE GRADING

Site grading plans can result in changes in almost all aspects of foundation recommendations. We have prepared all foundation recommendations based on the existing ground surface and the stratigraphic conditions encountered at the time of our study. If site grading plans differ from existing grade by more than plus or minus 1 ft, RKCI must be retained to review the site grading plans prior to bidding the project for construction. This will enable RKCI to provide input for any changes in our original recommendations that may be required as a result of site grading operations or other considerations.

ENGINEERED BEAM AND SLAB FOUNDATION

The proposed library addition may be founded on a stiffened engineered beam and slab foundation, provided the selected foundation type can be designed to withstand the anticipated soil-related movements (see Expansive Soil-Related Movements) without impairing either the structural or the operational performance of the structure. If a shallow foundation is to be considered, we recommend that the Overexcavation and Select Fill Replacement option be utilized to reduce expansive soil-related movements.

Allowable Bearing Pressure

Shallow foundations founded on compacted, select fill should be proportioned using the design parameters tabulated below.
The above presented maximum allowable bearing pressures will provide a calculated factor of safety of about 3 with respect to the measured shear strength, provided the subgrade is prepared and fill is selected and placed as recommended in the Site Preparation and Select Fill sections of this report, respectively.

We recommend that a vapor barrier be placed between the supporting soils and the concrete floor slab.

Select Fill Shrinkage

Provided the select fill material used meets the requirements in the Select Fill section of this report and is placed in strict accordance with those recommendations, we estimate the select fill material beneath the floor slabs will experience shrinkage settlement on the order of 0.75 to 1 percent with about half of the settlement occurring during construction. It is estimated that differential settlement will be approximately half the total post-construction settlement provided that the differential pad thickness is limited to 4 ft or less.

Total settlements have been estimated for varying select fill building pad thicknesses for this site. These magnitudes of settlement are based on a percentage of the total fill thickness and can be utilized to estimate potential settlements for building pads at the site. If the anticipated total settlement is greater than the allowable settlement, the lower portion of the building fill pad may be constructed using compacted, cement treated lean clay fill as discussed in the Cement Stabilized Lean Clay Fill section of this report, and the thickness of the cement treated fill pad may be neglected for calculation of the total settlement in the table below. The remaining fill placed up to the finished grade elevation should be imported Select Fill. Recommendations for selection and placement of fill within the proposed building footprint are presented in the Select Fill section of this report. Imported, crushed limestone base should be utilized in at least the upper 3 ft of the select fill pad.

<table>
<thead>
<tr>
<th>Total Settlement for Uniform Select Fill Building Pads*</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 ft or less</td>
</tr>
<tr>
<td>1/2 in. or less</td>
</tr>
</tbody>
</table>

*Note: Post-construction settlement is anticipated to be half of the total settlement.

We recommend that the differential select fill pad thickness be limited to a maximum of 4 ft within the building footprint.
AREA FLATWORK

It should be noted that ground-supported flatwork such as walkways, courtyards, etc. will be subject to the same magnitude of potential soil-related movements as discussed previously (see Expansive Soil-Related Movement section). Thus, where these types of elements abut rigid building foundations or isolated/suspended structures, differential movements should be anticipated. As a minimum, we recommend that flexible joints be provided where such elements abut the main structure to allow for differential movement at these locations. Where the potential for differential movement is objectionable, it may be beneficial to consider methods of reducing anticipated movements or to consider structurally suspending critical areas to match the adjacent building performance.

We recommend a 5 ft transition zone around the building perimeter. This transition zone will slope up to the natural ground level from the building excavation. This transition area will have select fill material making the expansive nature less than natural ground.

OPEN CUT CONSIDERATIONS

If open cut excavation techniques are utilized, maximum side slopes of 1-1/2 to 1 (horizontal to vertical) should be anticipated for temporary construction slopes to depths of up to 20 ft.

DRILLED-AND-UNDERREAMED PIERS

Drilled-and-underreamed piers bearing in tan to tan and gray clay may be considered to support the library expansion structure. Due to the relatively high uplift forces anticipated (see Pier Shaft Potential Uplift Forces section), we recommend that piers extend to a minimum depth of 35 ft below the ground surface existing at the time of our study, or 30 ft below the final ground surface, whichever is greater. The piers should be designed as end bearing units using a maximum allowable bearing pressure of 11 ksf. This bearing pressure was evaluated using a calculated factor of safety of at least 3 with respect to the design shear strength. Based on the 50-ft maximum depth of exploration, pier depth should not exceed a depth of 45 ft below the ground surface existing at the time of our study.

Pier Shaft Potential Uplift Forces

The pier shafts will be subject to potential uplift forces if the surrounding expansive soils within the active zone are subjected to alternating drying and wetting conditions. The maximum potential uplift force acting on the shaft may be estimated using the table below:
where D is the pier diameter in ft. Where a crawl space is utilized, the depth of the crawl space relative to the surrounding grades should be included in the depth of overexcavation and select fill replacement.

**Allowable Uplift Resistance**

Resistance to uplift forces exerted on the drilled piers will be provided by the sustained axial compressive force (dead load) plus the allowable uplift resistance provided by the soil. The resistance provided by the soil depends on the bearing capacity of the soils located above the pier underream (bell) and below the active zone. The allowable uplift resistance for underreamed piers founded at the depth recommended above may be estimated using:

\[
R_u = 8.25 \times (B^2 - D^2)
\]

where:

- \(R_u\) = uplift resistance in kips;
- \(B\) = diameter of the underream in feet; and
- \(D\) = diameter of the shaft in feet.

Due to the blocky, slickensided nature of the tan and gray clays, we recommend that the bell-to-shaft diameter ratio be a minimum of 2, and not exceed 2.5. Reinforcing steel will be required in each pier shaft to withstand a net force equal to the uplift force minus the sustained compressive load carried by the pier. We recommend that each pier be reinforced to withstand this net force or an amount equal to 0.75 percent of the cross-sectional area of the shaft, whichever is greater.

**PIER SPACING**

Where possible, we recommend that the piers be spaced at a center to center distance of at least three bell-diameters for underreamed piers. Such spacing will not require a reduction in the load carrying capacity of the individual piers.
If design and/or construction restraints require that piers be spaced closer than the recommended three bell diameters, RKCI must re-evaluate the allowable bearing capacities presented above for the individual piers. Reductions in load carrying capacities may be required depending upon individual loading and spacing conditions.

**LATERAL RESISTANCE**

Resistance to lateral loads and the expected pier behavior under the applied loading conditions will depend not only on subsurface conditions, but also on loading conditions, the pier size, and the engineering properties of the pier. Once pier sizes, concrete strength, and reinforcement are finalized, piers should be analyzed to determine the resulting lateral deflection, maximum bending moment, and ultimate bending moment. This type of analysis is typically performed utilizing a computer analysis program and usually requires a trial and error procedure to appropriately size the piers and meet project tolerances.

To assist the design engineer in this procedure, we are providing the following soil parameters for use in analysis. These parameters are in accordance with the input requirements of one of the more commonly used computer programs for laterally loaded piles, the LPile program. If a different program is used for analysis, different parameters and limitations may be required than what were assumed in selecting the parameters given below. Thus, if a program other than LPile is used, RKCI must be notified of the analysis method, so that we can review and revise our recommendations if required. Evaluating the lateral resistance on different pier sizes is outside our scope of work at this time.

The soil-related parameters required for input into the LPile program are summarized in the tables below:

<table>
<thead>
<tr>
<th>Assumed Behavior for Analysis</th>
<th>Depth* (ft)</th>
<th>c (psf)</th>
<th>k_s (pci)</th>
<th>( \varepsilon_{50} )</th>
<th>( \gamma ) (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Clay (Matlock)</td>
<td>0 to 5</td>
<td>500</td>
<td>30</td>
<td>0.02</td>
<td>120</td>
</tr>
<tr>
<td>Stiff Clay without free water (Reese)</td>
<td>5 to 27</td>
<td>2,000</td>
<td>1,000</td>
<td>0.005</td>
<td>125</td>
</tr>
<tr>
<td>Stiff Clay without free water (Reese)</td>
<td>27 to 37</td>
<td>3,000</td>
<td>1,000</td>
<td>0.005</td>
<td>125</td>
</tr>
<tr>
<td>Stiff Clay without free water (Reese)</td>
<td>37 to 50</td>
<td>4,500</td>
<td>2,000</td>
<td>0.004</td>
<td>130</td>
</tr>
</tbody>
</table>

*Depth below the existing ground surface at the time of our study

Where:
- \( c \) = undrained cohesion
- \( k_s \) = p-y modulus (static)
- \( \varepsilon_{50} \) = strain factor
- \( \gamma \) = effective unit weight

The parameters presented in the above table do not include factors of safety. Per the general procedures of Section 1810.3.3.2 of the IBC 2015 edition, the allowable lateral capacity shall not exceed one-half of the lateral load that produces a lateral movement of 1 inch at the ground surface.
It should be noted that where piers are spaced closer than three shaft diameters center to center, a modification factor should be applied to the p-y curves to account for a group effect. We recommend the following p-Multipliers for the corresponding center to center pier spacings.

<table>
<thead>
<tr>
<th>Spacing (in shaft diameters)</th>
<th>p-Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>0.75</td>
</tr>
<tr>
<td>1</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**GRADE BEAMS AND FLOOR SLABS**

Two alternatives are available to construct the grade beam and floor slab system. The Owner may select the alternative best satisfying the required performance criteria.

**Alternative No. 1:** Grade beams and floor slabs that have high performance criteria or that are movement sensitive in nature should be structurally suspended because of the anticipated ground movements. A positive void space of at least 12 in., preferably more, should be provided between the slab/soffits of grade beams and the underlying soils (see also Crawl Space Considerations). Areas containing critical entry/exit points to the building, such as doorways, should consider using a suspended system to relieve those areas of heave stresses caused by expansive soils.

**Alternative No. 2:** Grade beams and floor slabs within the superstructure may be ground supported provided the anticipated movements discussed under the Expansive Soil-Related Movements section of this report will not impair the performance of the grade beam, floor, frame, or roof systems.

If the superstructure is supported on drilled piers while the floor slab is grade supported, any heave/settlement will be experienced as differential movement where it abuts the superstructure. Additionally as described in the Select Fill Settlement section of this report, we expect total settlement on the order of 1 percent of the fill thickness. If this magnitude of movement is deemed to be outside the structural or operational performance tolerance of the structure, the structurally suspended floor slab described above as Alternative No. 1 should be considered.

If differential movements between the slab and the structure are objectionable, soil-supported floor slabs could be dowelled to the perimeter grade beams. Dowelled slabs that are subjected to heaving will typically crack and develop a plastic hinge along a line which will be approximately 5 to 10 ft inside and parallel to the grade beams. Slabs cast independent of the grade beams, interior columns and partitions should experience minimum cracking, but may create difficulties at critical entry points such as doors and may impact interior partitions that are secured to exterior walls.
We recommend that a vapor barrier be placed between the supporting select fill and the concrete floor slab.

**ADDITIONAL CONSIDERATIONS**

As with any project where new additions are to be connected to an existing structure, differential movements between the existing structure and addition should be anticipated. This is especially true of this site, where expansive clays underlie the site. To reduce possible differential movements, it is typically desirable to match the old and the new foundation types. However, this will not eliminate the potential for differential movements since the existing and new structures are constructed at different times. Therefore, the recommendations and options discussed in this report should be carefully considered by the design team to obtain the desired performance of the new structural system. As a minimum, control/expansion joints are recommended at connection points between the old and new structures and between architectural trim materials along walls/ceilings.

Should excavations adjacent to existing structures be required, precautions should be taken not to undermine or damage existing grade beams, footings, and/or utility lines.

**FOUNDATION CONSTRUCTION CONSIDERATIONS**

**SITE DRAINAGE**

Drainage is an important key to the successful performance of any foundation. Good surface drainage should be established prior to and maintained after construction to help prevent water from ponding within or adjacent to the building foundation and to facilitate rapid drainage away from the building foundation. Failure to provide positive drainage away from the structure can result in localized differential vertical movements in soil supported foundations and floor slabs, which can in turn result in cracking in the sheetrock partition walls and shifting of ceiling tiles, as well as improper operation of windows and doors.

Current ordinances, in compliance with the Americans with Disabilities Act (ADA), may dictate maximum slopes for walks and drives around and into new buildings. These slope requirements can result in drainage problems for buildings supported on expansive soils. We recommend that, on all sides of the building, the maximum permissible slope be provided away from the building.

Also to help control drainage in the vicinity of the structure, we recommend that roof/gutter downspouts and landscaping irrigation systems not be located adjacent to the building foundation. Where a select fill overbuild is provided outside of the floor slab/foundation footprint, the surface should be sealed with an impermeable layer (pavement or clay cap) to reduce infiltration of both irrigation and surface waters. Careful consideration should also be given to the location of water bearing utilities, as well as to provisions for drainage in the event of leaks in water bearing utilities. All leaks should be immediately repaired.

Other drainage and subsurface drainage issues are discussed in the *Expansive Soil-Related Movements* section of this report and under *Pavement Construction Considerations*. 
SITE PREPARATION

Building areas and all areas to support select fill should be stripped of all vegetation and organic topsoil. Tree roots greater than 1 inch in diameter should be grubbed and removed. Furthermore, as discussed in a previous section of this report, if a shallow foundation system or a ground-supported floor system is chosen for the proposed structure, we recommend that the Overexcavation and Select Fill Replacement option be utilized to reduce expansive soil-related movements.

Exposed subgrades should be thoroughly proofrolled in order to locate weak, compressible zones. A minimum of 5 passes of a fully-loaded dump truck or a similar heavily-loaded piece of construction equipment should be used for planning purposes. Proofrolling operations should be observed by the Geotechnical Engineer or their representative to document subgrade condition and preparation. Weak or soft areas identified during proofrolling should be removed and replaced with suitable, compacted on-site clays, free of organics, oversized materials, and degradable or deleterious materials.

Wherever possible, foundation remnants, pavements, utility trenches and utility lines within the proposed building footprint should be completely removed. If deep foundation elements cannot be removed, they should be cut off a minimum of 2 ft, preferably more, beneath the bottom of any new floor slab or pavement. All areas within the building footprint should be excavated down to natural in-situ soils and the resulting excavations should then be backfilled to the top of subgrade elevation with compacted select fill prior to construction of the select structural building pad. We recommend that the design team give consideration to controlling the influx of water for any excavations at the earliest possible stage of design.

Where foundations (grade beams, continuous footings, spread footings, etc.) and pavements are removed, the subgrade should be scarified, moisture conditioned and compacted. The same condition applies to all utilities located in the area of the new structure.

Beyond the building pad footprint, existing utilities and trenches that are not removed should be properly abandoned. This would include grouting abandoned pipes and sealing off granular fill in utility trenches to prevent the migration and seepage of water into the building pad of the new building.

Upon completion of the proofrolling operations and just prior to fill placement or slab construction, the exposed subgrade should be moisture conditioned by scarifying to a minimum depth of 6 in. and recompressing to a minimum of 95 percent of the maximum density determined from TxDOT, Tex-114-E, Compaction Test. The moisture content of the subgrade should be maintained within the range of optimum moisture content to 3 percentage points above optimum moisture content until permanently covered.

SELECT FILL

The Expansive Soil Related Movements and Overexcavation and Select Fill sections of this report assume that the select fill utilized will follow the specifications below. Based on our understanding of the existing grades, proposed FFEs, and our overexcavation and select fill replacement estimates, the total fill thicknesses beneath the building pad may be as high as 10 ft; therefore, the following recommendations are crucial to the performance of the building pad and foundation. Additionally, with deep fills, the possibility of
differential settlement is increased. Fills placed beneath the building pad and foundation should be of uniform thickness and quality as detailed below.

**Imported Crushed Limestone Base** – Imported crushed limestone base materials should be crushed stone or gravel aggregate. We recommend that materials specified for use as select fill meet the TxDOT 2014 Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, Item 247, Flexible Base, Type A, Grade 1-2. The liquid limit of the material should not exceed 40 and the plasticity index should be between 7 and 20. The Select Fill material described in this paragraph should be utilized in at least the upper 3 ft of the Select Fill building pad.

As an option for the portion of the pad below the uppermost 3 ft of Type A, Grade 1-2 Select Fill, Alternative Select Fill materials meeting the requirements in the below paragraphs may be utilized.

**Recycled Materials** - Recycled materials (i.e. concrete) is a viable alternative to crushed limestone to be used as fill, provided that the recycled material is determined to be environmentally acceptable. We recommend that the recycled concrete material meet the below requirements (TxDOT Item 247) prior to hauling to the site.

Recycled material may be used as fill if deleterious materials can be separated (i.e. rebar, soil, wood, metal, plastic, piping, conduit, etc). Oversized rubble should be processed to a well-graded material similar to the *Imported Crushed Limestone Base* with a maximum particle size of 4 inches. Rubble larger than 4 inches in any dimension should be discarded or processed to the maximum dimension. Care should be taken when placing the fill that the larger pieces are not concentrated in a manner such that voids develop between nested pieces; a sufficient quantity of fines should be provided to reduce this risk.

If utilized, recycled materials should conform to TxDOT Item 247, Recycled Material 2.1.3.2 and 2.1.3.2.1.

2.1.3.2. Recycled Material (Including Crushed Concrete) Requirements.

2.1.3.2.1. **Contractor-Furnished Recycled Materials.** Provide recycled materials that have a maximum sulfate content of 3,000 ppm when tested in accordance with Tex-145-E. When the Contractor furnishes the recycled materials, including crushed concrete, the final product will be subject to the requirements of Table 1 for the grade specified. Certify compliance with DMS-11000, “Evaluating and Using Nonhazardous Recyclable Materials Guidelines,” for Contractor furnished recycled materials. In addition, recycled materials must be free from reinforcing steel and other objectionable material and have at most 1.5% deleterious material when tested in accordance with Tex-413-A. For RAP, do not exceed a maximum percent loss from decantation of 5.0% when tested in accordance with Tex-406-A. Test RAP without removing the asphalt.

**Low PI Materials** – Imported or on-site processed low PI materials should consist of low plasticity clay (CL), or sandy clay (SC), as classified according to the Unified Soil Classification System (USCS). Alternative select fill materials shall have a maximum liquid limit not exceeding 40, a plasticity index between 7 and 20, and a maximum particle size not exceeding 4 inch. In addition,
if these materials are utilized, grain size analyses and Atterberg Limits must be performed during placement at a rate of one test each per 5,000 cubic yards of material due to the high degree of variability associated with these materials, particularly the on-site processed material.

**Granular Pit Run Materials** – Granular pit run materials should consist of GC, SC & combination soils (clayey gravels), as classified according to the Unified Soil Classification System (USCS). Alternative select fill materials shall have a maximum liquid limit not exceeding 40, a plasticity index between 7 and 20, and a maximum particle size not exceeding 4 inch. In addition, if these materials are utilized, grain size analyses and Atterberg Limits must be performed during placement at a rate of one test each per 5,000 cubic yards of material due to the high degree of variability associated with these materials.

If the above-listed materials are being considered for bidding purposes, the materials should be submitted to the Geotechnical Engineer for evaluation at a minimum of 10 working days or more prior to the bid date. Failure to do so will be the responsibility of the contractor. The contractor will also be responsible for ensuring that the properties of all delivered alternate select fill materials are similar to those of the pre-approved submittal. **It should also be noted that when using alternative fill materials such as Granular Pit Run, or Low PI Materials, difficulties may be experienced with respect to moisture control during and subsequent to fill placement, as well as with erosion, particularly when exposed to inclement weather. This may result in sloughing of beam trenches and/or pumping of the fill materials.**

*Granular Pit Run, or Low PI Materials,* will be very susceptible to small changes in moisture content and to disturbance from foot traffic during the placement of steel reinforcement in beam trenches, particularly in periods of inclement weather. Disturbance from such foot traffic and from the accumulation of excess water can result in losses in bearing capacity and increased settlement. If inclement weather is anticipated at the time construction, consideration should be given to protecting the bottom of foundation excavations by placing a thin mud mat (layer of flowable fill or lean concrete) at the bottom of trenches immediately following excavation. This will reduce disturbance from foot traffic and will impede the infiltration of surface water. The side slopes of beam trench excavations may also need to be flattened to reduce sloughing in cohesionless soils. All necessary precautions should be implemented to protect open excavations from the accumulation of surface water runoff and rain.

Soils classified as CH, MH, ML, SM, GM, OH, OL and Pt under the USCS are not considered suitable for use as select fill materials at this site.

**Select Fill Placement and Compaction**

Select fill should be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 95 percent of maximum density as determined by ASTM D1557. The moisture content of the fill should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content until final compaction.
General Fill Placement and Compaction

The remaining fill (such as parking lot areas or green/lawn spaces) may be compacted to at least 95 percent of maximum density as determined by TxDOT, Tex-114-E, Compaction Test, or ASTM D698. The moisture content of the fill should be maintained within the range of optimum to plus 3 percentage points above the optimum moisture content until final compaction.

Cement Stabilized Lean Clay Fill

When Portland cement is utilized for stabilizing subgrade soil, a proper mix design is critical to the success of the section. Tex-120-E should be used for performing the mix designs.

The percentage of cement selected for use with base material should result in an average unconfined compressive strength ranging from 200 to 300 psi. In no case should the unconfined compressive strength of the stabilized material exceed 350 psi. Cement treatment of the material should be in accordance with the TxDOT 2014 Standard Specifications, Item 275.

SHALLOW FOUNDATION EXCAVATIONS

Shallow foundation excavations should be observed by the Geotechnical Engineer or their representative prior to placement of reinforcing steel and concrete. This is necessary to observe that the bearing soils at the bottom of the excavations are similar to those encountered in our borings and that excessive loose materials and water are not present in the excavations. If soft pockets of soil are encountered in the foundation excavations, they should be removed and replaced with a compacted non-expansive fill material or lean concrete up to the design foundation bearing elevations.

DRILLED PIERS

Each drilled pier excavation must be examined by an RKCI representative who is familiar with the geotechnical aspects of the soil stratigraphy, the structural configuration, foundation design details and assumptions, prior to placing concrete. This is to observe that:

- The shaft and bell has been excavated to the specified dimensions at the correct depth established by the previously mentioned criteria;
- The bell is concentric with the pier shaft;
- The shaft has been drilled plumb within specified tolerances along its total length; and
- Excessive cuttings, buildup and soft, compressible materials have been removed from the bottom of the excavation.

Based on visual observations, the tan and gray clays are blocky. This may result in sloughing within the bell at the time of construction. As previously recommended, the bell-to-shaft diameter ratio should not exceed 2.5 to improve constructability of the underreams in these clays.
Reinforcement and Concrete Placement

Reinforcing steel should be checked for size and placement prior to concrete placement. Placement of concrete should be accomplished as soon as possible after excavation to reduce changes in the moisture content or the state of stress of the foundation materials. No foundation element should be left open overnight without concreting.

EXCAVATION SLOPING AND BENCHING

If utility trenches or other excavations extend to or below a depth of 5 ft below construction grade, the contractor or others shall be required to develop a trench safety plan to protect personnel entering the trench or trench vicinity. The collection of specific geotechnical data and the development of such a plan, which could include designs for sloping and benching or various types of temporary shoring, are beyond the scope of the current study. Any such designs and safety plans shall be developed in accordance with current OSHA guidelines and other applicable industry standards.

EXCAVATION EQUIPMENT

Our boring logs are not intended for use in determining construction means and methods and may therefore be misleading if used for that purpose. We recommend that earth-work and utility contractors interested in bidding on the work perform their own tests in the form of test pits to determine the quantities of the different materials to be excavated, as well as the preferred excavation methods and equipment for this site.

CRAWL SPACE CONSIDERATIONS

If the structurally suspended floor system described as Alternative No. 1 under the Floor Slab section of this report is selected, several special design issues should be considered for the resulting subfloor crawl space. These issues are discussed below.

Ventilation

Observations by members of our firm of open crawl spaces have indicated a need for adequate subfloor ventilation for suspended floor systems. Such ventilation helps promote evaporation of subgrade moisture which may accumulate in spite of special surface and subsurface drainage features. As a minimum, free flowing passive vents may need to be installed along the perimeter beam to provide cross ventilation. If structural configurations will limit the free flow of air through passive vents, forced air, power vents should be installed. All vents should be designed such that they will not allow the drainage of surface water into the crawl space.
Below Slab Utilities

A minimum clearance of 12 in. has been recommended between both the grade beams and floor slab and the underlying finished subgrade should a suspended floor system be employed. Such a minimum clearance is also recommended between the subgrade and any utilities which may be suspended from the underside of the floor. This clearance will allow swell-related subgrade movements without damaging the utilities. It is recommended that the utility clearance not be provided by the addition of narrow trenches running parallel to and immediately below the utilities, unless proper slopes and drainage outlets are provided to prevent ponding of water in the trenches.

Drainage

As discussed throughout this report, positive drainage is a key factor in the long term performance of any foundation. This is not only critical around the perimeter of the structure, but also in any subfloor crawl spaces. In crawl areas, surface drainage should be established that will direct water away from and will prevent water from ponding adjacent to piers. This positive drainage should be maintained both prior to and after construction.

Compaction control of the backfill around the perimeter of the building following the placement of soil retainer blocks is critical to the drainage away from the building following construction. Materials for the backfill around the perimeter of the building should be the on-site clays. These materials should be compacted in uniformly thin lifts (8-inch maximum loose thickness) to at least 90 percent of the maximum dry density as determined by TxDOT Test Method Tex-114-E. These clays should be placed and compacted at optimum to plus 3 percent above optimum moisture content. Compaction by hand operated mechanical tampers will help to avoid damage to the soil retainer blocks. Following backfilling operations the soil retainer blocks should be checked to see that they have not been broken or collapsed during the compaction operations. Any soil retainer blocks that are broken or collapsed should be repaired or replaced.

Carton Forms

When carton forms are used to form subfloor void spaces, the forms often get wet or sometimes absorb water from humid air. This can result in collapse of the forms during the placement of concrete, thus diminishing the design void space. Conversely, if the carton forms are too strong and do not decompose sufficiently with time, they may not collapse as soil heave occurs, resulting in heave damage to the floor slab. Where there is sufficient moisture to cause the appropriate deterioration after construction, there may be a resulting moisture problem in the floor slab as a result of poor ventilation and the accumulation of condensation within the resulting unventilated void space. The lack of ventilation may also result in increased soil movements that will diminish the design void space. For these reasons, we recommend that where possible, consideration be given to methods other than the use of carton forms to form the recommended void space beneath floor slabs. If project specifics require the use of carton forms, then as a minimum, care should be taken to ensure that the carton forms are designed for use in the project location, and that carton forms are properly stored, protected, and installed during construction.
**INTERIOR WALLS**

It is not uncommon for cracking to occur in interior partition walls that are supported by a “floating” floor slab and structurally tied to either an interior column or an exterior wall supported by deep foundations. This should be taken into account during the design phase of the project if a “floating” slab foundation is used to support the proposed building.

**UTILITIES**

Utilities which project through slab-on-grade, slab-on-fill, “floating” floor slabs, or any other rigid unit should be designed with either some degree of flexibility or with sleeves. Such design features will help reduce the risk of damage to the utility lines as vertical movements occur. These types of slabs will generally be constructed as monolithic, grid type beam and slab foundations or as a “floating” floor slab described as Alternative No. 2 under the Floor Slab section of this report.

Our experience indicates that significant settlement of backfill can occur in utility trenches, particularly when trenches are deep, when backfill materials are placed in thick lifts with insufficient compaction, and when water can access and infiltrate the trench backfill materials. The potential for water to access the backfill is increased where water can infiltrate flexible base materials due to insufficient penetration of curbs, and at sites where geological features can influence water migration into utility trenches (such as fractures within a rock mass or at contacts between rock and clay formations). It is our belief that another factor which can significantly impact settlement is the migration of fines within the backfill into the open voids in the underlying free-draining bedding material.

To reduce the potential for settlement in utility trenches, we recommend that consideration be given to the following:

- All backfill materials should be placed and compacted in controlled lifts appropriate for the type of backfill and the type of compaction equipment being utilized and all backfilling procedures should be tested and documented.
- Curbs should completely penetrate base materials and be installed to a sufficient depth to reduce water infiltration beneath the curbs into the pavement base materials.
- Consideration should be given to wrapping free-draining bedding gravels with a geotextile fabric (similar to Mirafi 140N) to reduce the infiltration and loss of fines from backfill material into the interstitial voids in bedding materials.

**PAVEMENT RECOMMENDATIONS**

Recommendations for both flexible and rigid pavements are presented in this report. The Owner and/or design team may select either pavement type depending on the performance criteria established for the project. In general, flexible pavement systems have a lower initial construction cost as compared to rigid pavements. However, maintenance requirements over the life of the pavement are typically much greater for flexible pavements. This typically requires regularly scheduled observation and repair, as well as overlays and/or other pavement rehabilitation at approximately one-half to two-thirds of the design...
life. Rigid pavements are generally more “forgiving”, and therefore tend to be more durable and require less maintenance after construction.

For either pavement type, drainage conditions will have a significant impact on long term performance, particularly where permeable base materials are utilized in the pavement section. Drainage considerations are discussed in more detail in a subsequent section of this report.

SUBGRADE CONDITIONS

We have assumed the subgrade in pavement areas will consist of native dark brown fat clay or recompacted on-site clays, placed and compacted as recommended in the On-Site Clay Fill section of this report. Based on our experience with similar subgrade soils, we have assigned a California Bearing Ratio (CBR) value of 2.5 for use in pavement thickness design analyses.

DESIGN INFORMATION

The following recommendations were prepared based on the 1993 “Guide for the Design of Pavement Structures” by the American Association of State Highway and Transportation Officials (AASHTO). The following recommendations were prepared assuming a 20‐yr design life and Equivalent Single Axle Loads (ESALs) of 15,000 for light duty pavements and 50,000 for heavy duty pavements. This traffic frequency is approximately equivalent to 1 and 3 tractor-trailer trucks per day for a design period of 20 years for light and heavy duty pavements, respectively. The Project Civil Engineer should review anticipated traffic loading and frequencies to verify that the assumed traffic loading and frequency is appropriate for the intended use of the facility.

FLEXIBLE PAVEMENT

Flexible pavement sections recommended for this site are as listed in the table below:

<table>
<thead>
<tr>
<th>Layer Description</th>
<th>Layer Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Duty – 15,000 ESALs (parking areas)</td>
<td></td>
</tr>
<tr>
<td>HMAC Surface Course, Type “D”</td>
<td>2.0 in.</td>
</tr>
<tr>
<td>Flexible Base</td>
<td>10.0 in.</td>
</tr>
<tr>
<td>Lime Treated Subgrade</td>
<td>8.0 in.</td>
</tr>
<tr>
<td>Combined Total</td>
<td>20.0 in.</td>
</tr>
<tr>
<td>Medium Duty – 50,000 ESALs (entrances, driveways, and channelized traffic areas)</td>
<td></td>
</tr>
<tr>
<td>HMAC Surface Course, Type “D”</td>
<td>2.0 in.</td>
</tr>
<tr>
<td>Flexible Base</td>
<td>13.0 in.</td>
</tr>
<tr>
<td>Lime Treated Subgrade</td>
<td>8.0 in.</td>
</tr>
<tr>
<td>Combined Total</td>
<td>23.0 in.</td>
</tr>
</tbody>
</table>

Garbage Dumpsters

Where flexible pavements are constructed at any site, we recommend that reinforced concrete pads be provided in front of and beneath trash receptacles. The dumpster trucks, if any, should be parked on the rigid pavement when the receptacles are lifted.
It is suggested that such pads also be provided in drives where the dumpster trucks make turns with small radii to access the receptacles. The concrete pads at this site should be a minimum of 6 in. thick and reinforced with conventional steel reinforcing bars.

**RIGID PAVEMENT**

We recommend that rigid pavements be considered in areas of channelized traffic, particularly in areas where truck or bus traffic is planned, and particularly where such traffic will make frequent turns, such as described above for garbage dumpster areas. We recommend that rigid pavement sections at this site consist of the following:

<table>
<thead>
<tr>
<th>Traffic Type</th>
<th>Portland Cement Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Duty Traffic</td>
<td>5 in.</td>
</tr>
<tr>
<td>Heavy Duty Traffic</td>
<td>6 in.</td>
</tr>
</tbody>
</table>

We recommend that the concrete pavements be reinforced with bar mats. As a minimum, the bar mats should be No. 3 reinforcing bars spaced 18 in. on center in both directions. The concrete reinforcing should be placed approximately 1/3 the slab thickness below the surface of the slab, but not less than 2 in. The reinforcing should not extend across expansion joints.

Joints in concrete pavements aid in the construction and control the location and magnitude of cracks. Where practical, lay out the construction, expansion, control and sawed joints to form square panels. The ratio of slab length-to-width should not exceed 1.25. Maximum recommended joint spacings are 12 ft longitudinal and 12 ft transverse.

All control joints should be formed or sawed to a depth of at least 1/4 the thickness of the concrete slab. Sawing of control joints should begin as soon as the concrete will not ravel, generally the day after placement. Control joints may be hand formed or formed by using a premolded filler. We recommend that all longitudinal and transverse construction joints be dowelled to promote load transfer. Expansion joints are needed to separate the concrete slab from fixed objects such as drop inlets, light standards and buildings. Expansion joint spacings are not to exceed a maximum of 75 ft and no expansion or construction joints should be located in a swale or drainage collection locations.

If possible, the pavement should develop a minimum slope of 0.015 ft/ft to provide surface drainage. Reinforced concrete pavement should cure a minimum of 3 and 7 days before allowing automobile and truck traffic, respectively.

**PAVEMENT CONSTRUCTION CONSIDERATIONS**

**SUBGRADE PREPARATION**

Areas to support pavements should be stripped of all vegetation and organic topsoil and the exposed subgrade should be proofrolled in accordance with the recommendations in the *Site Preparation* section under *Foundation Construction Considerations*. Additionally, existing foundations and pavements
(including flexible base materials) should be completely removed from proposed pavement areas prior to construction, as discussed in the Site Preparation section of this report.

After completion of the proofrolling operations and just prior to flexible base placement, the exposed subgrade should be moisture conditioned by scarifying to a minimum depth of 6 in. and recompacting to a minimum of 95 percent of the maximum density determined from the Texas Department of Transportation Compaction Test (TxDOT, Tex-114-E). The moisture content of the subgrade should be maintained within the range of optimum moisture content to 3 percentage points above optimum until permanently covered.

DRAINAGE CONSIDERATIONS

As with any soil-supported structure, the satisfactory performance of a pavement system is contingent on the provision of adequate surface and subsurface drainage. Insufficient drainage which allows saturation of the pavement subgrade and/or the supporting granular pavement materials will greatly reduce the performance and service life of the pavement systems.

Surface and subsurface drainage considerations crucial to the performance of pavements at this site include (but are not limited to) the following:

1) Any known natural or man-made subsurface seepage at the site which may occur at sufficiently shallow depths as to influence moisture contents within the subgrade should be intercepted by drainage ditches or below grade French drains.

2) Final site grading should eliminate isolated depressions adjacent to curbs which may allow surface water to pond and infiltrate into the underlying soils. Curbs should completely penetrate base materials and should be installed to sufficient depth to reduce infiltration of water beneath the curbs.

3) Pavement surfaces should be maintained to help minimize surface ponding and to provide rapid sealing of any developing cracks. These measures will help reduce infiltration of surface water downward through the pavement section.

ON-SITE CLAY FILL

The pavement recommendations presented in this report were prepared assuming that on-site soils will be used for fill grading in proposed pavement areas. If used, we recommend that on-site soils be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 95 percent of the maximum density as determined by TxDOT, Tex-114-E. The moisture content of the fill should be maintained within the range of optimum water content to 3 percentage points above the optimum water content until permanently covered. We recommend that fill materials be free of roots and other organic or degradable material. We also recommend that the maximum particle size not exceed 4 in. or one half the lift thickness, whichever is smaller.
LIME TREATMENT OF SUBGRADE

Lime treatment of the subgrade soils should be in accordance with the TxDOT Standard Specifications, Item 260. A sufficient quantity of hydrated lime should be mixed with the subgrade soils until either the pH of the soil-lime mixture is at least 12.4 or higher concentrations of lime do not increase the pH, as specified in Part III of TxDOT procedure Tex-121-E, Soil Lime Testing. For estimating purposes, we recommend that 5 percent lime by weight be assumed for treatment. For construction purposes, we recommend that the optimum lime content of the subgrade soils be determined by laboratory testing.

Lime-treated subgrade soils should be compacted to a minimum of 95 percent of the maximum density at a moisture content within the range of optimum moisture content to 3 percentage points above the optimum moisture content as determined by Tex-113-E. We recommend that lime treatment extend at least 3 ft beyond the curb.

If lime treatment is considered as a method to improve pavement subgrade conditions, it is also recommended to perform additional laboratory testing to determine the concentration of soluble sulfates in the subgrade soils, in order to investigate the potential for a recently reported adverse reaction to lime in certain sulfate-containing soils. The adverse reaction, referred to as sulfate-induced heave, has been known to cause cohesive subgrade soils to swell in short periods of time, resulting in pavement heaving and possible failure.

FLEXIBLE BASE COURSE

The flexible base course should be crushed limestone conforming to TxDOT Standard Specifications, Item 247, Type A, Grade 1-2. Base course should be placed in lifts with a maximum thickness of 8 in. and compacted to a minimum of 95 percent of the maximum density at a moisture content within the range of 2 percentage points below to 2 percentage points above the optimum moisture content as determined by Tex-113-E. The plasticity index should be maintained between 7 and 20.

ASPHALTIC CONCRETE SURFACE COURSE

The asphaltic concrete surface course should conform to TxDOT Standard Specifications, Item 340, Type D. The asphaltic concrete should be compacted to a minimum of 92 percent of the maximum theoretical specific gravity (Rice) of the mixture determined according to Test Method Tex-227-F. Pavement specimens, which shall be either cores or sections of asphaltic pavement, will be tested according to Test Method Tex-207-F. The nuclear-density gauge or other methods which correlate satisfactorily with results obtained from project roadway specimens may be used when approved by the Engineer. Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required roadway specimens at their expense and in a manner and at locations selected by the Engineer.

PORTLAND CEMENT CONCRETE

The Portland cement concrete should be air entrained to result in a 4 percent plus/minus 1 percent air, should have a maximum slump of 5 inches, and should have a minimum 28-day compressive strength of
3,000 psi. A liquid membrane-forming curing compound should be applied as soon as practical after broom finishing the concrete surface. The curing compound will help reduce the loss of water from the concrete. The reduction in the rapid loss in water will help reduce shrinkage cracking of the concrete.

The Mr of concrete is a measure of the flexural strength of the concrete as determined by breaking concrete beam test specimens. A M, of approximately 450 to 550 psi at 28 days was used in the analysis and is typical of local concrete production.

CONSTRUCTION RELATED SERVICES

CONSTRUCTION MATERIALS TESTING AND OBSERVATION SERVICES

As presented in the attachment to this report, Important Information About Your Geotechnical Engineering Report, subsurface conditions can vary across a project site. The conditions described in this report are based on interpolations derived from a limited number of data points. Variations will be encountered during construction, and only the geotechnical design engineer will be able to determine if these conditions are different than those assumed for design.

Construction problems resulting from variations or anomalies in subsurface conditions are among the most prevalent on construction projects and often lead to delays, changes, cost overruns, and disputes. These variations and anomalies can best be addressed if the geotechnical engineer of record, RKCI is retained to perform construction observation and testing services during the construction of the project. This is because:

- RKCI has an intimate understanding of the geotechnical engineering report’s findings and recommendations. RKCI understands how the report should be interpreted and can provide such interpretations on site, on the client’s behalf.
- RKCI knows what subsurface conditions are anticipated at the site.
- RKCI is familiar with the goals of the owner and project design professionals, having worked with them in the development of the geotechnical workscope. This enables RKCI to suggest remedial measures (when needed) which help meet the owner’s and the design teams’ requirements.
- RKCI has a vested interest in client satisfaction, and thus assigns qualified personnel whose principal concern is client satisfaction. This concern is exhibited by the manner in which contractors’ work is tested, evaluated and reported, and in selection of alternative approaches when such may become necessary.
- RKCI cannot be held accountable for problems which result due to misinterpretation of our findings or recommendations when we are not on hand to provide the interpretation which is required.
BUDGETING FOR CONSTRUCTION TESTING

Appropriate budgets need to be developed for the required construction testing and observation activities. At the appropriate time before construction, we advise that RKCI and the project designers meet and jointly develop the testing budgets, as well as review the testing specifications as it pertains to this project.

Once the construction testing budget and scope of work are finalized, we encourage a preconstruction meeting with the selected contractor to review the scope of work to make sure it is consistent with the construction means and methods proposed by the contractor. RKCI looks forward to the opportunity to provide continued support on this project, and would welcome the opportunity to meet with the Project Team to develop both a scope and budget for these services.

* * * * * * * * * * * * * * *
BORING LOCATION MAP

WESTSIDE COMMUNITY CENTER LIBRARY EXPANSION
2932 SOUTH IH-35 FRONTAGE ROAD
NEW BRAUNFELS, TEXAS

SOURCE: Aerial imagery obtained from Google Earth Pro - 2018

NOTES: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

LEGEND
- BORING
- PROPOSED PAVEMENT
- PROPOSED STRUCTURE

PROJECT No.: ANA19-062-00
ISSUE DATE: 01/14/2020
DRAWN BY: CCL/JMR
CHECKED BY: DAB
REVIEWED BY: TIP

FIGURE 1
LOG OF BORING NO. B-1
Westside Community Center Library Expansion
2932 South IH 35 Frontage Road
New Braunfels, Texas

DRILLING METHOD: Straight Flight Auger

DESCRIPTION OF MATERIAL

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ASPHALT (1 in.)
BASE MATERIAL (7 in.)
CLAY, Stiff, Dark Brown, with gravel and ferric staining
CLAY, Very Stiff, Tan and Gray, mottled, blocky
-gypsum deposits below 20 ft
CLAY, Very Stiff to Hard, Tan, with gypsum deposits and silt

PLASTICITY INDEX

SHEAR STRENGTH, TONS/FT²

UNIT DRY WEIGHT, pcf

DEPTH DRILLED: 49.8 ft
DATE DRILLED: 1/3/2020
DEPTH TO WATER: Dry
DATE MEASURED: 1/3/2020
PROJ. No.: ANA19-062-00
FIGURE: 1a

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT
CLAY, Very Stiff to Hard, Tan, with gypsum deposits and silt (continued)

CLAY, Hard, Gray

Boring Terminated

NOTES:
1. Groundwater not encountered during drilling operations.
2. Boring backfilled with auger cuttings and capped with asphalt.
<table>
<thead>
<tr>
<th>Depth, ft</th>
<th>Description of Material</th>
<th>Blows per ft</th>
<th>Plasticity Index</th>
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<tbody>
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<td>0-5</td>
<td>CLAY, Stiff, Dark Brown, with gravel</td>
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<td>5-10</td>
<td>CLAY, Very Stiff, Tan, with abundant calcareous material</td>
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<td>10-15</td>
<td>CLAY, Very Stiff, Tan and Gray, mottled and blocky</td>
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<td>-with gypsum deposits below 29 ft</td>
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**LOCATION:** N 29.68030; W 98.14722

**DRILLING METHOD:** Straight Flight Auger

**LOG OF BORING NO. B-2**

**DESCRIPTION OF MATERIAL**

**SYMBOL**

**SAMPLES**

**DEPTH DRILLED:** 49.4 ft  **DATE DRILLED:** 1/3/2020  **DEPTH TO WATER:** Dry  **DATE MEASURED:** 1/3/2020  **PROJ. No.:** ANA19-062-00  **FIGURE:** 2a

**NOTE:** THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT
LOG OF BORING NO. B-2
Westside Community Center Library Expansion
2932 South IH 35 Frontage Road
New Braunfels, Texas

NOTES:
1. Groundwater not encountered during drilling operations.
2. Boring backfilled with auger cuttings.

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<td>CLAY, Very Stiff to Hard, Tan, with gypsum deposits (continued)</td>
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<td>CLAY, Hard, Gray</td>
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Boring Terminated

**DESCRIPTION OF MATERIAL**

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<th>BLOWS PER FT</th>
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**LOCATION:** N 29.68030; W 98.14722

**DRILLING METHOD:** Straight Flight Auger

**LOCATION:** Westside Community Center Library Expansion
2932 South IH 35 Frontage Road
New Braunfels, Texas

**NOTES:** These logs should not be used separately from the project report.
**LOG OF BORING NO. P-1**

Westside Community Center Library Expansion  
2932 South IH 35 Frontage Road  
New Braunfels, Texas

**LOCATION:** N 29.68036; W 98.14772

**PLASTICITY INDEX**

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<td>WATER CONTENT</td>
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<td>UNIT DRY WEIGHT, pcf</td>
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<td>SHEAR STRENGTH, TONS/FT²</td>
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**BLOWS PER FT**

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**DESCRIPTION OF MATERIAL**

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- **ASPHALT (2 in.)**
- **BASE MATERIAL (7 in.)**
- **CLAY, Stiff, Dark Brown**
- **with gravel below 3 ft**
- **Boring Terminated**

**NOTES:**
1. Groundwater not encountered during drilling operations.
2. Boring backfilled with auger cuttings and capped with asphalt.

**DEPTHS**

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**PROJ. No.:** ANA19-062-00  
**FIGURE:** 3
LOG OF BORING NO. P-2
Westside Community Center Library Expansion
2932 South IH 35 Frontage Road
New Braunfels, Texas

DRILLING METHOD: Straight Flight Auger

<table>
<thead>
<tr>
<th>DEPTH, FT</th>
<th>SYMBOL</th>
<th>SAMPLES</th>
<th>DESCRIPTION OF MATERIAL</th>
<th>BLOWS PER FT</th>
<th>UNIT DRY WEIGHT,pcf</th>
<th>PLASTIC LIMIT</th>
<th>LIQUID LIMIT</th>
<th>WATER CONTENT</th>
<th>SHEAR STRENGTH, TONS/FT²</th>
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<tbody>
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<td>5</td>
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<td>ASPHALT (4 in.)</td>
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<td></td>
<td>BASE MATERIAL (6 in.)</td>
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<tr>
<td>5</td>
<td></td>
<td></td>
<td>CLAY, Stiff, Dark Brown, with gravel and ferric staining</td>
<td>10</td>
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<td></td>
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<td></td>
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</table>

Boring Terminated

NOTES:
1. Groundwater not encountered during drilling operations.
2. Boring backfilled with auger cuttings and capped with asphalt.

LOCATION: N 29.68077; W 98.14710

DEPTH DRILLED: 5.0 ft
DATE DRILLED: 1/3/2020
DATE MEASURED: 1/3/2020
PROJ. No.: ANA19-062-00
FIGURE: 4
**LOG OF BORING NO. P-3**

Westside Community Center Library Expansion  
2932 South IH 35 Frontage Road  
New Braunfels, Texas

**DRILLING METHOD:** Straight Flight Auger  

**LOCATION:** N 29.68047; W 98.14696

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<th>UNIT DRY WEIGHT, pcf</th>
<th>PLASTIC LIMIT</th>
<th>LIQUID LIMIT</th>
<th>WATER CONTENT</th>
<th>SHEAR STRENGTH, TONS/FT²</th>
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<td>3.0</td>
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**NOTES:**
1. Groundwater not encountered during drilling operations.
2. Boring backfilled with auger cuttings.

**DEEPHT DRILLED:** 5.0 ft  
**DATE DRILLED:** 1/3/2020  
**DEPTH TO WATER:** Dry  
**DATE MEASURED:** 1/3/2020  
**PROJ. No.:** ANA19-062-00  
**FIGURE:** 5
### Material Types

#### Soil Terms
- Calcareous
- Caliche
- Clay
- Clayey
- Gravel
- Gravelly
- Cuttings

#### Rock Terms
- Chalk
- Claystone
- Clay-shale
- Conglomerate
- Dolomite
- Igneous
- Limestone
- Marl
- Metamorphic
- Sandstone
- Shale
- Base

#### Other
- Asphalt
- Concrete/Cement
- Brick / Pavers
- Waste
- No Information

### Well Construction and Plugging Materials

- Blank Pipe
- Screen
- Bentonite
- Bentonite & Cuttings
- Cuttings
- Cements GROUT
- Concrete/Cement
- Gravel
- Sand
- Volclay

### Sample Types

- Air Rotary
- Grab Sample
- Core
- Geoprobe Sampler
- Rotosonic Damaged
- Rotosonic Intact
- Mud Rotary
- No Recovery
- Nx Core
- Pitcher
- Disturbed

### Strength Test Types

- Pocket Penetrometer
- Torvane
- Unconfined Compression
- Triaxial Compression Unconsolidated-Undrained
- Triaxial Compression Consolidated-Undrained

**Note:** Values symbolized on boring logs represent shear strengths unless otherwise noted.
### Key to Terms and Symbols (Cont'd)

#### Terminology

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of **Soils Mechanics in Engineering Practice**, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the **Unified Soil Classification System**, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e. 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

#### Relative Density

<table>
<thead>
<tr>
<th>Penetration Resistance Blows per ft</th>
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<tr>
<td>0 - 4</td>
<td>Very Loose</td>
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<tr>
<td>4 - 10</td>
<td>Loose</td>
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<tr>
<td>10 - 30</td>
<td>Medium Dense</td>
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<tr>
<td>30 - 50</td>
<td>Dense</td>
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<td>&gt; 50</td>
<td>Very Dense</td>
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#### Cohesive Strength

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<th>Resistance Blows per ft</th>
<th>Consistency</th>
<th>Cohesion TSF</th>
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<td>Soft</td>
<td>0.125 - 0.25</td>
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<tr>
<td>4 - 8</td>
<td>Firm</td>
<td>0.25 - 0.5</td>
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<tr>
<td>8 - 15</td>
<td>Stiff</td>
<td>0.5 - 1.0</td>
</tr>
<tr>
<td>15 - 30</td>
<td>Very Stiff</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>Hard</td>
<td>&gt; 2.0</td>
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#### Plasticity

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<td>None</td>
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<td>Low</td>
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<tr>
<td>10 - 20</td>
<td>Moderate</td>
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<tr>
<td>20 - 40</td>
<td>Plastic</td>
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<td>&gt; 40</td>
<td>Highly Plastic</td>
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#### Abbreviations

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<th>Acronym</th>
<th>Explanation</th>
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<td>B</td>
<td>Benzene</td>
</tr>
<tr>
<td>T</td>
<td>Toluene</td>
</tr>
<tr>
<td>E</td>
<td>Ethylbenzene</td>
</tr>
<tr>
<td>X</td>
<td>Total Xylenes</td>
</tr>
<tr>
<td>BTEX</td>
<td>Total BTEX</td>
</tr>
<tr>
<td>TPH</td>
<td>Total Petroleum Hydrocarbons</td>
</tr>
<tr>
<td>ND</td>
<td>Not Detected</td>
</tr>
<tr>
<td>NA</td>
<td>Not Analyzed</td>
</tr>
<tr>
<td>NR</td>
<td>Not Recorded/No Recovery</td>
</tr>
<tr>
<td>OVA</td>
<td>Organic Vapor Analyzer</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts Per Million</td>
</tr>
<tr>
<td>Qam, Qas, Qal</td>
<td>Quaternary Alluvium</td>
</tr>
<tr>
<td>Qat</td>
<td>Low Terrace Deposits</td>
</tr>
<tr>
<td>Qbc</td>
<td>Beaumont Formation</td>
</tr>
<tr>
<td>Qt</td>
<td>Fluvial Terrace Deposits</td>
</tr>
<tr>
<td>Qao</td>
<td>Seymour Formation</td>
</tr>
<tr>
<td>Qle</td>
<td>Leona Formation</td>
</tr>
<tr>
<td>Q-Tu</td>
<td>Uvalde Gravel</td>
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<tr>
<td>Ewi</td>
<td>Wilcox Formation</td>
</tr>
<tr>
<td>Emi</td>
<td>Midway Group</td>
</tr>
<tr>
<td>Mc</td>
<td>Catahoula Formation</td>
</tr>
<tr>
<td>EL</td>
<td>Laredo Formation</td>
</tr>
<tr>
<td>Kf</td>
<td>Fort Terrett Member</td>
</tr>
<tr>
<td>Kgt</td>
<td>Georgetown Formation</td>
</tr>
<tr>
<td>Kep</td>
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<td>Kek</td>
<td>Kainer Formation</td>
</tr>
<tr>
<td>Kes</td>
<td>Escondido Formation</td>
</tr>
<tr>
<td>Kew</td>
<td>Walnut Formation</td>
</tr>
<tr>
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<td>Glen Rose Formation</td>
</tr>
<tr>
<td>Kgru</td>
<td>Upper Glen Rose Formation</td>
</tr>
<tr>
<td>Kgrl</td>
<td>Lower Glen Rose Formation</td>
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<tr>
<td>Kh</td>
<td>Hensell Sand</td>
</tr>
</tbody>
</table>

**BTEX**

- Benzene
- Toluene
- Ethylbenzene
- Total Xylenes
- Total BTEX
- Total Petroleum Hydrocarbons
- Not Detected
- Not Analyzed
- Not Recorded/No Recovery
- Organic Vapor Analyzer
- Parts Per Million

**Abbreviations**

- **Qam, Qas, Qal** = Quaternary Alluvium
- **Qat** = Low Terrace Deposits
- **Qbc** = Beaumont Formation
- **Qt** = Fluvial Terrace Deposits
- **Qao** = Seymour Formation
- **Qle** = Leona Formation
- **Q-Tu** = Uvalde Gravel
- **Ewi** = Wilcox Formation
- **Emi** = Midway Group
- **Mc** = Catahoula Formation
- **EL** = Laredo Formation
- **Kef** = Eagle Ford Shale
- **Kbu** = Buda Limestone
- **Kdr** = Del Rio Clay
- **Kft** = Fort Terrett Member
- **Kgt** = Georgetown Formation
- **Kep** = Person Formation
- **Kek** = Kainer Formation
- **Kes** = Escondido Formation
- **Kew** = Walnut Formation
- **Kgr** = Glen Rose Formation
- **Kgru** = Upper Glen Rose Formation
- **Kgrl** = Lower Glen Rose Formation
- **Kh** = Hensell Sand
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<th>Water Content (%)</th>
<th>Liquid Limit</th>
<th>Plastic Limit</th>
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<th>USCS</th>
<th>Dry Unit Weight (pcf)</th>
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<td>69</td>
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<td>58</td>
<td>CH</td>
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PP = Pocket Penetrometer    TV = Torvane    UC = Unconfined Compression    FV = Field Vane    UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

**Important Information about This Geotechnical-Engineering Report**

**Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects**

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared solely for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. And no one — not even you — should apply this report for any purpose or project except the one originally contemplated.

**Read the Full Report**

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

**Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors**

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client’s goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it’s changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

**Subsurface Conditions Can Change**

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. Do not rely on a geotechnical-engineering report whose adequacy may have been affected by: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. Contact the geotechnical engineer before applying this report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

**Most Geotechnical Findings Are Professional Opinions**

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

**A Report’s Recommendations Are Not Final**

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report’s confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations’ applicability.

**A Geotechnical-Engineering Report Is Subject to Misinterpretation**

Other design-team members’ misinterpretation of geotechnical-engineering reports has resulted in costly
problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team’s plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer’s Logs
Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Constructors a Complete Report and Guidance
Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, but prefacing it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report’s accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. Be sure constructors have sufficient time to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely
Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered
The equipment, techniques, and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. Do not rely on an environmental report prepared for someone else.

Obtain Professional Assistance To Deal with Mold
Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the express purpose of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold-prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical-engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; none of the services performed in connection with the geotechnical engineer’s study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance
Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your GBC-Member geotechnical engineer for more information.
ENGINEERING • ENVIRONMENTAL • INFRASTRUCTURE • PROJECT CONTROL

Austin, TX  San Antonio, TX  Lake Worth, FL
Brownsville, TX  Houston, TX  Lincoln, NE
Dallas, TX  McAllen, TX  Salt Lake City, UT
Freeport, TX  New Braunfels, TX  Mexico
Project No. ANA19-062-00
May 4, 2020

Mr. Joshua A. Niles
City of New Braunfels
550 Landa Street
New Braunfels, Texas 78130

RE: Geotechnical Engineering Study – Supplemental Letter
Westside Community Center Library Expansion
New Braunfels, Texas

Dear Mr. Niles:

RABA KISTNER Consultants, Inc. (RKCI) is pleased to present this letter providing supplemental foundation recommendations for the above referenced project. No additional field or laboratory sampling or testing were completed in the preparation of this supplemental letter. This letter should not be used separately from the original report, RKCI Project No. ANA19-062-00, dated February 3, 2020. All other recommendations remain as stated in the original report.

On the basis of a letter provided to RKCI by JQ Engineering, LLP (JQ) dated April 14, 2020, it is our understanding that due to budget and functional constraints, the design team is considering a structural slab on void boxes. JQ has indicated that they have had success on previous projects using void boxes by providing a vapor retarder between the boxes and the bottom of the floor slab as well as providing specifications that require proper delivery, storage and placement of void boxes. Furthermore, in order to facilitate this recommendation, JQ is requesting that we provide an updated void depth, if necessary.

Provided that the above specifications are implemented, RKCI takes no exception to the use of carton forms, or void boxes to construct the suspended slab. The resulting void space should be 12 in. or greater between the floor slab and the underlying soils, the utilities and the underlying soils, as well as the soffits of the grade beams and the underlying soils.

It is also our understanding that a covered walkway is planned between the existing building and the proposed library. We further understand that the new building is planned to be approximately 12 ft 4-1/8 in. from the existing building and that columns are planned to support the covered walkway. This may limit the ability to provide a minimum 3 bell diameter spacing between adjacent (proposed and/or existing) foundation elements. In order to provide allowable bearing capacity reduction factors, RKCI would prefer to review the instances that the recommended pier spacing cannot be met on a case-by-case basis. Additionally, it is important to understand the foundation type and geometry of the existing building to ensure that the new construction does not impede this pier spacing (should piers be supporting the existing building), and that additional stresses will not be exerted on the soils supporting the existing foundation elements.
Important information which will assist in evaluating potentially reducing the bearing capacity to facilitate construction of the piers include:

- existing foundation type and geometries;
- proposed foundation locations relative to each other and existing foundation elements; and
- proposed loads for the new construction (both downward axial and uplift conditions).

Possible solutions to avoid or reduce the impact of the reduction factors may include sizing the piers and bells such that the pier spacing can be met, reducing loads on the piers to reduce the size of the piers, and/or offsetting the bearing elevations to reduce the impact of stress overlap. Depending on the controlling load on the pier (axial, uplift, or lateral), the pier type may be switched to straight-shaft provided that the loading criteria can be achieved.

* * * * * * * * * * * * * * *

We appreciate the opportunity to be of service on this project, please call or email if you have any questions.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

T. Ian Perez, P.E.
Associate

TIP/
Copies Submitted: Above (Email Only)
Mr. Tom R. Herrin, P.E. – JQ Engineering, LLP (Email only)
Ms. Beth A. Feero, P.E. – JQ Engineering, LLP (Email only)
Dear Mr. Niles:

RABA KISTNER Consultants, Inc. (RKCI) is pleased to present this letter providing supplemental foundation recommendations for the canopy located between the existing building and proposed new building planned at the above referenced project. No additional field or laboratory sampling or testing were completed in the preparation of this supplemental letter. This letter should not be used separately from the original report, RKCI Project No. ANA19-062-00, dated February 3, 2020. All other recommendations remain as stated in the original report.

The recommendations presented in this letter are based on discussions with Ms. Beth Feero, P.E. with JQ, the project structural engineers and Sheet A0.01 Architectural Site Plan of the 90 percent plans prepared by Komatsu Architects and dated May 8, 2020. It is our understanding that the canopy structure will be located between the new proposed library building and the existing gym building. We also understand that the existing building foundation type is unknown and as-built drawings of the structure are unavailable. The proposed building foundation will be comprised of a suspended system supported on drilled-and-underreamed piers. Within this letter we have included recommendations for drilled, straight shaft pier foundations for the canopy structure.

Our understanding of the proposed canopy is that it will be structurally independent from both the existing and proposed buildings and that expansion joints will be included between both the existing and proposed buildings and the canopy flatwork. We understand that the distance between the perimeter of the existing building and proposed canopy columns is on the order of 4 ft 8 in. Overexcavation and select fill replacement to a depth of 6 ft below the finished grade elevation will be completed to reduce the uplift force acting on the piers from 85*D to 42*D, per the recommendations in our original report. We understand that the canopy columns will induce a downward axial load of 10 kips with an uplift force of 6 kips.

In order to accommodate the 6 ft of overexcavation and select fill replacement in the canopy area and to reduce the potential for undermining the foundation of the existing building, we recommend that the
overexcavation be sloped where it is adjacent to the existing building. Where the overexcavation is adjacent to the existing building, the existing soils should be overexcavated to a depth of 2 ft below finished grade. The excavation should then slope downward from the point 2 ft below finished grade adjacent to the existing building at 1:1 (Horizontal:Vertical), uniformly downward and away from the building until the planned overexcavation elevation is achieved.

**Drilled, Straight- Shaft Piers**

We recommend that frilled, straight-shaft piers be utilized to support the proposed canopy. Straight-shaft piers should be designed as friction units using an allowable side shear resistance of 720 psf for the portion of the shaft extending below the 6 ft select fill pad to a depth of 30 ft below the existing ground surface, and 970 psf for the portion of the shaft extending below 30 ft to the 50 ft maximum exploration depth. We recommend that the piers extend an elevation of 30 ft or deeper. This allowable side shear resistance was evaluated using a calculated factor of safety of at least 2. Based on the 50 ft maximum depth of exploration, pier depths should not exceed a depth of 50 ft below the ground surface existing at the time of our study.

Drilled, straight-shaft piers bearing at a minimum depth of 30 ft below the existing ground surface may also be proportioned using a maximum allowable end bearing pressure of 7.8 ksf, which increases to 18.75 ksf should the piers be founded in native, intact, gray clay which was encountered at a depth of 43 ft below existing grade. However, we recommend that a minimum of 70 percent of the applied load be carried in side shear. We recommend that the depth of the straight shaft piers be limited due to the unknown foundation system of the existing building.

Final shaft depths will be based on interpretation of conditions in the field at the time of construction. Due to the variable conditions at this site, RKCI must be present at the time of pier construction to verify the field conditions are similar to those assumed in the preparation of our recommendations. For bid purposes, the owner should anticipate that deeper piers will be required in some areas. Consequently, contractors bidding on the job should include unit costs for various depths of additional pier embedment. Unit costs should include those for both greater and lesser depths in soil.

**Allowable Uplift Resistance** Resistance to uplift forces exerted on the drilled, straight-shaft piers will be provided by the sustained compressive axial force (dead load) plus the allowable uplift resistance provided by the soil. The resistance provided by the soil depends on the shear strength of the soils adjacent to the pier shaft and below the depth of the active zone. The allowable uplift resistance provided by the soils at this site may be estimated as 480 psf for the portion of the shaft below the 6 ft select fill pad to a depth of 30 ft below the existing ground surface, and 640 psf for the portion extending below 30 ft to the 50 ft maximum exploration depth. This value was evaluated using a factor of safety of 2.

Reinforcing steel will be required in each pier shaft to withstand a net force equal to the uplift force minus the sustained compressive load carried by that pier. We recommend that each pier be reinforced to withstand this net force or an amount equal to 0.75 percent of the cross-sectional area of the shaft, whichever is greater.
Pier Spacing  Where possible, we recommend that the piers be spaced at a center to center distance of at least 3 shaft diameters on-center for straight-shaft piers, but should maintain a spacing of at least 2 shaft diameters between adjacent elements to maintain the capacities presented above.

In the case where varying shaft diameters are installed adjacent to one another, the larger diameter pier will control the spacing recommendations. Where straight shaft piers are located adjacent to drilled-and-underreamed piers, the shaft diameter should be utilized to determine the spacing between foundation elements. In addition, the drilled-and-underreamed piers adjacent to straight-shaft piers should be extended to be founded at a depth 5 ft below the bearing elevation of the straight shaft piers to reduce the potential for concurrent stresses acting on the bearing soils. Such spacing will not require a reduction in the load carrying capacity of the individual piers.

If design and/or construction restraints require that piers be spaced closer than recommended, RKCI must re-evaluate the allowable bearing capacities presented above for the individual piers. Reductions in load carrying capacities may be required depending upon individual loading and spacing conditions.

Additional Considerations

Because the foundation type, size, and loading of the existing building are unknown, any excavations adjacent and within 5 ft of the building perimeter should be completed with care to reduce the potential for compromising the existing foundations. Drilled pier excavations adjacent to the existing building should proceed slowly to gauge the presence of shallow spread footings. Should existing foundations be encountered, RKCI should be retained to evaluate the presence of the foundations and the locations of the proposed columns.

* * * * * * * * * * * * * * * * *

We appreciate the opportunity to be of service on this project, please call or email if you have any questions.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

Dylan A. Bunn, E.I.T.  
Graduate Engineer

T. Ian Perez, P.E.  
Associate
GENERAL CONDITIONS

1.1 GENERAL CONDITIONS
A. The "General Conditions of the Contract for Construction", AIA Document A201, Sixteenth Edition, 2015, Articles 1 through 15 inclusive, is a part of this Contract, and is available for review from the Architect. The General Conditions and all modifications listed hereinafter shall apply to all various subcontracts and sub-subcontractors.
B. Refer to Document 008000 for Supplementary Conditions.

END OF DOCUMENT
1.1 SUPPLEMENTS
A. The following supplements modify, change, delete from or add to the "General Conditions of the Contract for Construction", AIA Document A201, Sixteenth Edition, 2007. Where any Article of the General Conditions is modified or any Paragraph, Subparagraph or Clause thereof is modified or deleted by these supplements, the unaltered provision of the Article, Paragraph, Subparagraph or Clause shall remain in effect.

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

ARTICLE 1 - GENERAL PROVISIONS

Add the following new paragraphs:

1.1.9 MISCELLANEOUS DEFINITIONS
1.1.9.1 The term "Product" as used in these Contract Documents includes materials, systems, and equipment.
1.1.9.2 The term "provide" as used in this Project Manual means to furnish and install.

1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

Add the following new subparagraphs:

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

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

ARTICLE 3 - CONTRACTOR

3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

Add following sentences to subparagraph 3.2.2:

3.2.2.1 If a dimensional discrepancy exists, Contractor shall take field measurements required for proper fabrication and installation of work. Upon commencement of any item of work, Contractor shall be responsible for dimensions related to such item of Work and shall make any corrections necessary to make work properly fit at no additional cost to Owner.
3.2.2.2 Before ordering any material or doing any work, Contractor shall verify dimensions and check conditions in order to assure himself that they properly reflect those on the Drawings. Any inconsistency shall be brought to attention of the Architect. In the event that discrepancies occur between ordered material and actual conditions, of which Architect was not notified beforehand, costs to correct such discrepancies shall be borne by Contractor.

3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

Supplement as provided in Division 1.

3.4 LABOR AND MATERIALS

Add the following new paragraph:

3.4.4 After the Contract has been executed, the Owner and the Architect will consider a formal request for the substitution of products in place of those specified only under the conditions set forth in the General Requirements of the Specifications, Division 1. Refer to Division 01 for supplemental information.

3.5 WARRANTY

Supplement as provided in Division 01.

3.8 ALLOWANCES

Supplement as provided in Division 01.

3.10 CONTRACTOR'S CONSTRUCTION SCHEDULES

Supplement as provided in Division 01.

3.11 DOCUMENTS AND SAMPLES AT THE SITE

Supplement as provided in Division 01.

3.12 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

Supplement as provided in Division 01.

3.13 USE OF SITE

Supplement as provided in Division 01.

3.14 CUTTING AND PATCHING

Supplement as provided in Division 01.

3.15 CLEANING UP

Supplement as provided in Division 01.
ARTICLE 6 - CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

Add the following new paragraph

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

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

ARTICLE 7 - CHANGES IN THE WORK

7.1 GENERAL

Supplement as provided in Division 1.

Add the following new paragraphs:

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

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

ARTICLE 8 - TIME

8.3 DELAYS AND EXTENSIONS OF TIME

Add the following new paragraphs

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

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

8.3.5.1 Document, in writing, that the weather on the particular day was of such nature (rain, wind, snow, ice, and subsequent resultant effects) that it significantly impacted its ability to make progress on critical path work items. Inclement weather delay days will not be granted for weekends or holidays unless Contractor can demonstrate that it had been and intended to work on these days.

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

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

ARTICLE 9 - PAYMENTS AND COMPLETION

9.2 SCHEDULE OF VALUES

Supplement as provided in Division 01.
9.3 APPLICATIONS FOR PAYMENT

Supplement as provided in Division 01.

Add the following new subparagraph:

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

Add following Sub-subparagraphs:

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

9.5 DECISIONS TO WITHHOLD CERTIFICATION

Add following Sub-subparagraph 9.5.1.8 to Subparagraph 9.5.1:

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

9.5.1.9 Failure to keep record documents current.

9.8 SUBSTANTIAL COMPLETION

Supplement as provided in Division 01.

9.10 FINAL COMPLETION AND FINAL PAYMENT

Add the following new paragraph

9.10.2.1 In addition to the items listed in 9.10.2, the Contractor shall deliver 4 sets of the following items to the Owner before final payment will be made:

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

ARTICLE 11 - INSURANCE AND BONDS

11.1 CONTRACTOR'S LIABILITY INSURANCE

Add the following new Sub-subparagraphs:

11.1.1.9 Liability insurance shall include all major divisions of coverage and be on a comprehensive basis including:

.1 Premises Operations (including X-C-U).
.2 Independent Contractor's Protective.
.3 Products and Completed Operations.
.4 Contractual including specified provisions for the Contractor's obligations under Paragraph 3.18.
.5. Broad Form Property Damage including Completed Operations.
.7. Owner's and Contractor's Protective.
.8. Excess Umbrella.

11.1.1.10 Insurance certificate(s) shall specify Owner as the certificate holder and (except for Workers' Compensation) as an additional insured.

11.1.2 Add the following to the first sentence after the word “law”

“or as otherwise required by the Owner”

ARTICLE 13 - MISCELLANEOUS PROVISIONS

13.5 TESTS AND INSPECTIONS

Supplement as provided in Division 01.
SECTION 011000
SUMMARY

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes:
   1. Project information.
   2. Work covered by Contract Documents.
   3. Phased construction.
   4. Work by Owner.
   5. Owner-furnished products.
   6. Access to site.
   7. Coordination with occupants.
   8. Work restrictions.

1.3 PROJECT INFORMATION
A. Project Identification: New Braunfels Westside Community Center Library.
   1. Project Location: 2932 South I-35 Frontage Road, New Braunfels, TX. 78130.
B. Owner: City of New Braunfels.
C. Architect: Komatsu Architecture, 3880 Hulen Street, Suite 300, Fort Worth, Texas 76109.
D. Contractor: TBD.
E. Project Web Site: A Project Web site administered by the Contractor will be used for purposes of managing communication and documents during the construction stage.
   1. See Division 01 Section “Project Management and Coordination” for Contractor's requirements for utilizing the Project Web site.

1.4 WORK COVERED BY CONTRACT DOCUMENTS
A. The Work of the Project is defined by the Contract Documents and consists of the following:
   1. Demolition of existing site work and hardscape features. Demolition and removal of an existing church building and out-buildings as indicated. New construction for an 8,800 square foot, one-story, Type 2-B construction library building with limestone masonry veneer and custom “Cor-Ten” sheet metal rainscreen cladding including sitework as indicated on the drawings, located in New Braunfels, Texas.
B. Type of Contract
   1. Project will be constructed under a single prime contract.

1.5 PHASED CONSTRUCTION
A. The Work shall be conducted in phases:
   1. General site phasing plan and detailed phased construction plan/schedule to be developed by GC/CMAR.
B. Before commencing Work of each phase, submit an updated copy of the Contractor's construction schedule showing the sequence, commencement and completion dates, and move-out and -in dates of Owner's personnel for all phases of the Work.

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

1.7 OWNER-FURNISHED PRODUCTS
A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products and making building services connections.
B. Owner-Furnished Products:
   1. TBD.
1.8 ACCESS TO SITE
   A. General: Contractor shall have limited use of Project site for construction operations as indicated on
      Drawings by the Contract limits and as indicated by requirements of this Section.

1.9 COORDINATION WITH OCCUPANTS
   A. Full Owner Occupancy: Owner will occupy site and adjacent building(s) during entire construction period.
      Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage.
      Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless
      otherwise indicated.
      1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not
         close or obstruct walkways, corridors, or other occupied or used facilities without written
         permission from Owner and approval of authorities having jurisdiction.
      2. Notify the Owner not less than 72 hours in advance of activities that will affect Owner's operations.

1.10 WORK RESTRICTIONS
   A. Work Restrictions, General: Comply with restrictions on construction operations.
      1. Comply with limitations on use of public streets and other requirements of authorities having
         jurisdiction.
      B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7 a.m. to 5
         p.m., Monday through Friday, except as otherwise indicated.
      1. Hours for Utility Shutdowns: As agreed upon with the Owner's Representative.
      C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless
         permitted under the following conditions and then only after providing temporary utility services according
         to requirements indicated:
         1. Notify Owner not less than two days in advance of proposed utility interruptions.
         2. Obtain Owner's written permission before proceeding with utility interruptions.
      D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration,
         odors, or other disruption to Owner occupancy with Owner.
         1. Notify Owner not less than two days in advance of proposed disruptive operations.
         2. Obtain Owner's written permission before proceeding with disruptive operations.
      E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances,
         operable windows, or outdoor air intakes.
      F. Employee Identification: Provide identification tags for Contractor personnel working on the Project site.
         Require personnel to utilize identification tags at all times.

1.11 SPECIFICATION AND DRAWING CONVENTIONS
   A. Specification Content: The Specifications use certain conventions for the style of language and the
      intended meaning of certain terms, words, and phrases when used in particular situations. These
      conventions are as follows:
      1. Imperative mood and streamlined language are generally used in the Specifications. The words
         "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is
         used within a sentence or phrase.
      2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
   B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all
      Sections in the Specifications.
   C. Drawing Coordination: Requirements for materials and products identified on the Drawings are described
      in detail in the Specifications. One or more of the following are used on the Drawings to identify materials
      and products:
      1. Terminology: Materials and products are identified by the typical generic terms used in the
         individual Specifications Sections.
      2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S.
         National CAD Standard and scheduled on Drawings.
      3. Keynoting: Materials and products are identified by reference keynotes referencing Specification
         Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 PROJECT
A. Project Name: Garland Road Apartments.
C. Refer to cover sheet for Architect's consultants.
D. The Project consists of new construction for 219 apartment units; one 4 story Type 5A construction apartment building, and one 4 story Type 5A construction apartment building above a one story Type 1A podium parking structure including all associated sitework, located in Dallas, Texas.

E. OWNER OCCUPANCY
F. Owner intends to occupy portions of the Project upon Substantial Completion of each building or portion of building. Confirm phasing of the work to accommodate owner's schedule.
G. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
H. Schedule the Work to accommodate Owner occupancy.

1.2 CONTRACTOR USE OF SITE AND PREMISES
A. Construction Operations: Limited to areas noted on Drawings.
   1. Owner occupancy.
   2. Work by Others.
B. Provide access to and from site as required by law and by Owner:
   1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
   2. Do not obstruct roadways, sidewalks, or other public ways without permit.
C. Existing building spaces may not be used for storage without Owner approval in writing.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION
SECTION 012200

UNIT PRICES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for unit prices.
B. Related Requirements:
   1. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
   2. Section 014000 "Quality Requirements" for general testing and inspecting requirements.

1.3 DEFINITIONS
A. Unit price as stated on the Bid Form, is an amount incorporated in the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES
A. Unit Price shall include the furnishing by the Contractor of all labor, tools, materials, machinery, appliances, plant, and equipment appurtenant to and necessary for the construction and for the completion of all work to which the Unit Price pertains.
B. Unit Price shall also include all profit; overhead expenses; bond; insurance; patent fees; royalties; risk due to the elements, delay, injuries, damages, or claims; and all other items not specifically mentioned that may be required to construct each item of the Work.
C. No other charges or mark-ups will be allowed to be applied to the Unit Price when the appropriate Contract Document modification is written.
D. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
E. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
F. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL
A. Refer to individual Sections of Specifications for the descriptions of units of work where the establishment of unit prices is required; the methods of measurement and pricing are specified therein.
B. It is recognized that Unit Price items are listed in the Bid Form, and that the Owner-Contractor Agreement records acceptance or rejection of each Unit Price, either as bid or as otherwise agreed upon by the date of the Agreement.
C. Utilization of Unit Prices shall be solely by means of Change Orders as specified in the General and Supplementary Conditions.
D. Each Unit Price shall be the total cost or credit to the Owner.
E. Unit Prices stated shall apply to both additive and deductive variations in quantities.
F. Unit Prices stated on the Bid Form, and subsequently included in the Agreement, shall remain in effect until date of Final Completion of the entire Work.

UNIT PRICES
012200 - 1
3.2 IMPLEMENTATION
A. The initial listing of unit prices to be quoted with bids in included at the end of this Section as "Unit Price Schedule."
B. Materials and methods for units of work covered by Unit Prices shall be in accordance with applicable product Specifications included in the Project Manual.

3.3 SCHEDULE OF UNIT PRICES
A. Unit Price No. 1 – Drilled Piers:
   1. For actual depth versus anticipated depth indicated on Drawings.
   2. Include cost of providing and placing casings in Base Contract.
   3. Reconciliation: Per pier diameter category for net add or deduct, not per individual pier.
   4. Diameter Categories:
      a. 18 inches.
      b. 24 inches.
      c. 30 inches.
      d. 36 inches.
      e. 42 inches.
      f. 48 inches.
   5. For each diameter category pier required, provide:
      a. Unit price per additional lineal foot of completed pier.
      b. Unit price per deleted lineal foot of completed pier. This unit price shall be no less than 75 percent of unit price for additional lineal foot.
B. Unit Price No. 2 - Deletion of Casing: Base Bid price shall include casing of all piers to a depth of 20 feet below grade. Provide Unit Price for deletion of steel casing in its entirety in the event casing of piers is not required:
   1. Include cost of providing and placing casings in Base Contract.
   2. Reconciliation: Per pier diameter category for net deduct per individual pier.
C. Unit Price No. 3 - Addition of Casing: Base Bid price shall not include casing of drilled concrete piers. Provide Unit Price for addition of steel casing to a depth of 20 feet below grade in the event casing of piers is required by encountered subsurface conditions:
   1. Include cost of providing uncased drilled piers in Base Contract.
   2. Reconciliation: Per pier diameter category for net add per individual pier.
      a. 18 inches diameter piers, per pier.
      b. 24 inches diameter piers, per pier.
      c. 30 inches diameter piers, per pier.
      d. 36 inches diameter piers, per pier.
      e. 42 inches diameter piers, per pier.
      f. 48 inches diameter piers, per pier.

END OF SECTION
SECTION 012300
ALTERNATES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS
A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
   2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES
A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
   1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
C. Execute accepted alternates under the same conditions as other work of the Contract.
D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES
A. Alternate No. 1: (ADD) Garden.
   1. Base Bid: No work indicated.
   2. Alternate: Garden as indicated on Sheet L0.2.
B. Alternate No. 2: (ADD) Existing building demolition.
   1. Base Bid: No work indicated.
   2. Alternate: Demolition and removal of the existing Church building indicated on the Drawings and as specified in Division 2 Section “Building Demolition”.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for substitutions.

1.3 DEFINITIONS
A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 SUBMITTALS
A. Substitution Requests: Submit one PDF file of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use CSI Form 13.1A.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation can not be provided, if applicable.
      b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, where applicable or requested.
      f. Certificates and qualification data, where applicable or requested.
      g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
      h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
      i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
      j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
      k. Cost information, including a proposal of change, if any, in the Contract Sum.
      l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
      m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor of
acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.


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

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Modify or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

   a. Requested substitution is consistent with the Contract Documents and will produce indicated results.

   b. Substitution request is fully documented and properly submitted.

   c. Requested substitution will not adversely affect Contractor's construction schedule.

   d. Requested substitution has received necessary approvals of authorities having jurisdiction.

   e. Requested substitution is compatible with other portions of the Work.

   f. Requested substitution has been coordinated with other portions of the Work.

   g. Requested substitution provides specified warranty.

   h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed, unless otherwise indicated.

C. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Architect.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

   a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

   b. Requested substitution does not require extensive revisions to the Contract Documents.

   c. Requested substitution is consistent with the Contract Documents and will produce indicated results.

   d. Substitution request is fully documented and properly submitted.

   e. Requested substitution will not adversely affect Contractor's construction schedule.

   f. Requested substitution has received necessary approvals of authorities having jurisdiction.

   g. Requested substitution is compatible with other portions of the Work.

   h. Requested substitution has been coordinated with other portions of the Work.

   i. Requested substitution provides specified warranty.

   j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
SECTION 012500.13

SUBSTITUTION REQUEST FORM

PROJECT: _______________________________ (After Contract Award)

TO: _________________________________ _________________________________

NO. ____________                                               DATE: _________________________________

Contractor hereby requests acceptance of the following product or system as a substitution in accordance with provisions of Division 01 Section “Substitution Procedures:”

1. SPECIFIED PRODUCT OR SYSTEM

Substitution request for: _________________________________________________

Specification Section No.: _________________ Article/ Paragraph: _________________

2. REASON FOR SUBSTITUTION REQUEST

SPECIFIED PRODUCT . . . PROPOSED PRODUCT . . .

o Is no longer available. o Will reduce construction time

o Is unable to meet project schedule. o Will result in cost savings of

o Is unsuitable for the designated application. $ _________________ to Project

o Cannot interface with adjacent materials. o Is for supplier’s convenience

o Is not compatible with adjacent materials. o Is for subcontractor’s convenience

o Cannot provide the specified warranty. o Other:______________________________

o Cannot be constructed as indicated ________________________________ 

o Cannot be obtained due to one or more of the following:

  o Strike o Bankruptcy of manufacturer or supplier
  o Lockout o Similar occurrence (explain below)

3. SUPPORTING DATA

o Drawings, specifications, product data, performance data, test data, and any other necessary information to facilitate review of the Substitution Request are attached.

o Sample is attached. o Sample will be sent if requested.

4. QUALITY COMPARISON

Provide all necessary side-by-side comparative data as required to facilitate review of Substitution Request:

SPECIFIED PRODUCT PROPOSED PRODUCT

Manufacturer: __________________________ ___________________________

Name / Brand: __________________________ ___________________________
SUBSTITUTION REQUEST FORM

New Braunfels Westside Community Center Library
New Braunfels, Texas
Komatsu Architecture Project No. 2018.118

Catalog No.: __________________________
Vendor: __________________________
Variations: __________________________

(Add Additional Sheets If Necessary)

Local Distributor or Supplier: __________________________
Maintenance Service Available: o Yes o No
Spare Parts Source: __________________________________________
Warranty: o Yes o No _____ Years

5. PREVIOUS INSTALLATIONS

Identification of at least three similar projects on which proposed substitution was used:

PROJECT #1:
Project: __________________________________________
Address: __________________________________________
Architect: __________________________________________
Owner: __________________________________________
Contractor: __________________________________________
Date Installed: __________________________

PROJECT #2:
Project: __________________________________________
Address: __________________________________________
Architect: __________________________________________
Owner: __________________________________________
Contractor: __________________________________________
Date Installed: __________________________

PROJECT #3:
Project: __________________________________________
Address: __________________________________________
SUBSTITUTION REQUEST FORM
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New Braunfels Westside Community Center Library
New Braunfels, Texas
Komatsu Architecture Project No. 2018.118

Architect: _________________________________________ ______________
Owner: _______________________________________________________
Contractor: _______________________________________________________
Date Installed: _______________________________________________________

6. EFFECT OF SUBSTITUTION

Proposed substitution affects other work or trades:  o No  o Yes (if Yes, explain)
_______________________________________________________________________
_______________________________________________________________________

Proposed substitution requires dimensional revisions or redesign of architectural, structural, M-E-P, life safety, or other work:
   o No  o Yes (if Yes, attach data explaining revisions)
_______________________________________________________________________
_______________________________________________________________________

7. STATEMENT OF CONFORMANCE OF REQUEST TO CONTRACT REQUIREMENTS

Contractor and Subcontractor have investigated the proposed substitution and hereby represent that:
A. They have personally investigated the proposed substitution and believe that it is equal to or superior in all respects to specified product, except as stated above;
B. The proposed substitution is in compliance with applicable codes and ordinances;
C. The proposed substitution will provide same warranty as specified for specified product;
D. They will coordinate the incorporation of the proposed substitution into the Work, and will include modifications to the Work as required to fully integrate the substitution;
E. They have included complete cost data and implications of the substitution (attached);
F. They will pay any redesign fees incurred by the Architect or any of the Architect’s consultants, and any special inspection costs incurred by the Owner, caused by the use of this product;
G. They waive all future claims for added cost or time to the Contract related to the substitution, or that become known after substitution is accepted.
H. The Architect’s approval, if granted, will be based upon reliance upon data submitted and the opinion, knowledge, information, and belief of the Architect at the time decision is rendered and Addendum is issued; and that Architect’s approval therefore is interim in nature and subject to reevaluation and reconsideration as additional data, materials, workmanship, and coordination with other work are observed and reviewed.

Contractor:________________________________________________________ ______
   (Name of Contractor)
   Date:___________________ By: _______________________________________

Subcontractor:__________________________________________________________
   (Name of Subcontractor)
   Date:___________________ By: ______________________ _________________

Note: Unresponsive or incomplete requests will be rejected and returned without review.

8. ARCHITECT’S REVIEW AND ACTION
SUBSTITUTION REQUEST FORM

New Braunfels Westside Community Center Library
New Braunfels, Texas
Komatsu Architecture Project No. 2018.118

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o Substitution is accepted.

o Substitution is accepted, with the following comments: __________________________


___________________________________________________________________

o Resubmit Substitution Request:

  o Provide more information in the following areas: __________________________

  ________________________________________________________________

  o Provide proposal indicating amount of savings / credit to Owner

  o Bidding Contractor shall sign Bidder’s Statement of Conformance

  o Bidding Subcontractor shall sign Bidder’s Statement of Conformance

o Substitution is not accepted:

  o Substitution Request received too late.

  o Substitution Request received directly from subcontractor or supplier.

  o Substitution Request not submitted in accordance with requirements.

  o Substitution Request Form is not properly executed.

  o Substitution Request does not indicate what item is being proposed.

  o Insufficient information submitted to facilitate proper evaluation.

  o Proposed product does not appear to comply with specified requirements.

  o Proposed product will require substantial revisions to Contract Documents.

By: __________________________________________

Date: _______________________

Architect has relied upon the information provided by the Contractor, and makes no claim as to the accuracy, completeness, or validity of such information. If an accepted substitution is later found to be not in compliance with the Contract Documents, Contractor shall provide the specified product.

9. OWNER’S REVIEW AND ACTION

  o Substitution is accepted; Architect to prepare Change Order.

  o Substitution is not accepted.

  o Owner will pay Architect directly for redesign fees.

  o Include Architect’s Additional Service fee for implementing the substitution in the Change Order.

By: _____________________________________________________________________
SUBSTITUTION REQUEST FORM

END OF FORM
SECTION 012600
CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
B. Related Sections:
   1. Division 01 Section "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.

1.3 MINOR CHANGES IN THE WORK
A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions." or Architect's Bulletin form.

1.4 PROPOSAL REQUESTS
A. Owner-Initiated Proposal Requests: will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Proposal Requests issued by are not instructions either to stop work in progress or to execute the proposed change.
   2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating the cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributable to the change.
      d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
      e. Quotation Form: Use CSI Form 13.6B "Proposal Worksheet Summary" and 13.6C "Proposal Worksheet Detail". AIA G709 or Architect's Bulletin form.
B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to the Owner the Architect.
   1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
   2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
   4. Include costs of labor and supervision directly attributable to the change.
   5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
   6. Comply with requirements in Division 01 Section "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
   7. Proposal Request Form: Use Contractors standard proposal request form as approved by Owner and Architect.
1.5 ADMINISTRATIVE CHANGE ORDERS
   A. Allowance Adjustment: Refer to Division 01 Section "Allowances" for administrative procedures for
      preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
   B. Unit Price Adjustment: Refer to Division 01 Section "Unit Prices" for administrative procedures for
      preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit
      price work.

1.6 CHANGE ORDER PROCEDURES
   A. On Owner's approval of a Proposal Request, prepare and issue a Change Order for signatures of Owner,
      Architect and Contractor on AIA Document G701 or Contractors standard change order document.

1.7 CONSTRUCTION CHANGE DIRECTIVE
   A. Work Change Directive: Owner may instruct the Architect to issue a Work Change Directive on
      AIA Document G714 or Architect's Bulletin form. Work Change Directive instructs Contractor to proceed
      with a change in the Work, for subsequent inclusion in a Change Order.
      1. Work Change Directive contains a complete description of change in the Work. It also designates
         method to be followed to determine change in the Contract Sum or the Contract Time.
   B. Documentation: Maintain detailed records on a time and material basis of work required by the Work
      Change Directive.
      1. After completion of change, submit an itemized account and supporting data necessary to
         substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)
PAYMENT PROCEDURES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section specifies administrative and procedural requirements necessary to prepare and process
      Applications for Payment.

1.3 DEFINITIONS
   A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to
      various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES
   A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's
      construction schedule.
   1. Correlate line items in the schedule of values with other required administrative forms and
      schedules, including the following:
      a. Application for Payment forms with continuation sheets.
      b. Submittal schedule.
      c. Items required to be indicated as separate activities in Contractor's construction schedule.
   2. Sub-schedules for Phased Work: Where the Work is separated into phases requiring separately
      phased payments; provide sub-schedules showing values correlated with each phase of payment.
   B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the
      schedule of values. Provide at least one line item for each Specification Section.
   1. Identification: Include the following Project identification on the schedule of values:
      a. Project name and location.
      b. Name of Architect.
      c. Architect's project number.
      d. Contractor's name and address.
      e. Date of submittal.
   2. Arrange schedule of values consistent with format of AIA Document G703.
   3. Arrange the schedule of values in tabular form with separate columns to indicate the following for
      each item listed:
      a. Related Specification Section or Division.
      b. Description of the Work.
      c. Name of subcontractor.
      d. Name of manufacturer or fabricator.
      e. Name of supplier.
      f. Change Orders numbers that affect value.
      g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth
         percent, adjusted to total 100 percent.
         1) Labor.
         2) Materials.
         3) Equipment.
   4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of
      Applications for Payment and progress reports. Coordinate with the Project Manual table of
      contents. Provide multiple line items for principal subcontract amounts in excess of five percent of
      Contract Sum.
   5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
   6. Provide a separate line item in the schedule of values for each part of the Work where Applications
      for Payment may include materials or equipment purchased or fabricated and stored, but not yet
      installed.
      a. Differentiate between items stored on-site and items stored off-site. Include evidence of
         insurance and photo documentation.
7. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

8. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.

9. Purchase Contracts: Provide a separate line item in the schedule of values for each purchase contract. Show line-item value of purchase contract. Indicate owner payments or deposits, if any, and balance to be paid by Contractor.

10. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.

11. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT
A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
   1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Application for Payment Forms: Use AIA Document G702 or other Contractor form as approved by Owner / Architect, and AIA Document G703 as form for Applications for Payment.

D. Application for Payment Forms: Use forms acceptable to and Owner for Applications for Payment. Submit forms for approval with initial submittal of schedule of values.

E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
   1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
   2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
   3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
   4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.

F. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
   1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
   2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
   3. Provide summary documentation for stored materials indicating the following:
      a. Materials previously stored and included in previous Applications for Payment.
      b. Work completed for this Application utilizing previously stored materials.
      c. Additional materials stored with this Application.
      d. Total materials remaining stored, including materials with this Application.

G. Transmittal: Submit one signed and notarized original copies of each Application for Payment to by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
   1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

H. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
   1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

I. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
2. Schedule of values.
3. Contractor's construction schedule (preliminary if not final).
4. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
5. Products list (preliminary if not final).
6. Schedule of unit prices.
7. Submittal schedule (preliminary if not final).
8. List of Contractor's staff assignments.
12. Initial progress report.
14. Certificates of insurance and insurance policies.
15. Performance and payment bonds.
16. Data needed to acquire Owner's insurance.

J. Submit evidence of correction of non-conforming work prior to subsequent application for payment.

K. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

L. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
SECTION 013100
PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General project coordination procedures.
   2. Administrative and supervisory personnel.
   3. Coordination drawings.
   4. Requests for Information (RFIs).
   5. Project Web site.
   6. Project meetings.
B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

1.3 DEFINITIONS
A. RFI: Request from Owner, Architect, or Contractor seeking information from each other during construction.

1.4 COORDINATION
A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.
B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
   1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of Contractor's construction schedule.
   2. Preparation of the schedule of values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of submittals.
   5. Progress meetings.
   6. Pre-Installation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.
   9. Project closeout activities.

1.5 COORDINATION DRAWINGS
A. Coordination Drawings, General: Prepare coordination drawings in accordance with requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
   1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the
following information, as applicable:

a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.

b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.

c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.

d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.

e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.

f. Indicate required installation sequences.

g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

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

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire protection, fire alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.

2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.

3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire protection, fire alarm, and electrical equipment.

4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.

5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.

6. Mechanical and Plumbing Work: Show the following:
   a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
   b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
   c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:
   a. Runs of vertical and horizontal conduit 1-1/4 inch 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.

8. Fire Protection System: Show the following:
   a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor’s responsibility. If the Architect determines that the coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, the Architect will so inform the Contractor, who shall make changes as directed and resubmit.

10. Coordination Drawing Prints: Prepare coordination drawing prints in accordance with requirements of Division 01 Section “Submittal Procedures.”

C. Coordination Digital Data Files: Prepare coordination digital data files in accordance with the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as the original Drawings.

2. File Preparation Format: DWG. Version, operating in Microsoft Windows operating system.

3. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format and Portable Data File (PDF) format.
   a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings.
   b. Digital Data Software Program: The Drawings are available in AutoCAD 2013 (.dwg) Revit 2018 and are not backwards compatible (.rvt).
   c. Contractor shall execute a data licensing agreement in the form of Agreement included in this Project Manual.

1.6 KEY PERSONNEL
   A. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
   1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.7 REQUESTS FOR INFORMATION (RFIs)
   A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI. All RFIs should be sent directly to the Architect via email or posted to project collaboration site (if one is being utilized). The Architect will redistribute to the appropriate reviewer.
   1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
   B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
      1. Project name.
      2. Project number.
      3. Date.
      4. Name of Contractor.
      5. Name of Architect.
      6. RFI number, numbered sequentially.
      7. RFI subject.
      8. RFI Question
      9. Specification Section number and title and related paragraphs, as appropriate.
     10. Drawing number and detail references, as appropriate.
     11. Field dimensions and conditions, as appropriate.
     12. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
     13. Contractor's signature.
     14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
        a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
   C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect. RFIs should be emailed to Architect with the following format standards: 1) RFI should include RFI # in subject line of email along with brief description; 2) Body of email should include question or description of RFI and suggestion. Sketches or other necessary documents should be attached to email in PDF format.
   D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow 7 business days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
   1. The following RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for coordination information already indicated in the Contract Documents.
      d. Requests for adjustments in the Contract Time or the Contract Sum.
      e. Requests for interpretation of Architect's actions on submittals.
f. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.

3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
   a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

E. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Submit log with not less than the following:
   1. RFI Log Date
   2. Project name.
   3. Name and address of Contractor.
   4. Name and address of Architect and Construction Manager.
   5. RFI number including RFIs that were dropped and not submitted.
   6. RFI description.
   7. Date the RFI was submitted.
   8. Request Date
   9. Date Architect's and Construction Manager's response was received.
   10. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

1.8 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
   1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
   2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
   3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Pre-construction Conference: Schedule and conduct a pre-construction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
   1. Conduct the conference to review responsibilities and personnel assignments.
   2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
   3. Agenda: Discuss items of significance that could affect progress, including the following:
      a. Tentative construction schedule.
      b. Phasing.
      c. Critical work sequencing and long-lead items.
      d. Designation of key personnel and their duties.
      e. Lines of communications.
      f. Procedures for processing field decisions and Change Orders.
      g. Procedures for RFIs.
      h. Procedures for testing and inspecting.
      i. Procedures for processing Applications for Payment.
      j. Distribution of the Contract Documents.
      k. Submittal procedures.
      l. Sustainable design requirements.
      m. Preparation of record documents.
      n. Use of the premises and existing building.
      o. Work restrictions.
      p. Working hours.
      q. Owner's occupancy requirements.
      r. Responsibility for temporary facilities and controls.
      s. Procedures for moisture and mold control.
      t. Procedures for disruptions and shutdowns.
u. Construction waste management and recycling.
v. Parking availability.
w. Office, work, and storage areas.
x. Equipment deliveries and priorities.
y. First aid.
z. Security.
aa. Progress cleaning.

4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Pre-Installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
   b. Options.
   c. Related RFIs.
   d. Related Change Orders.
   e. Purchases.
   f. Deliveries.
   g. Submittals.
   h. Review of mockups.
   i. Possible conflicts.
   j. Compatibility problems.
   k. Time schedules.
   l. Weather limitations.
   m. Manufacturer’s written recommendations.
   n. Warranty requirements.
   o. Compatibility of materials.
   p. Acceptability of substrates.
   q. Temporary facilities and controls.
   r. Space and access limitations.
   s. Regulations of authorities having jurisdiction.
   t. Testing and inspecting requirements.
   u. Installation procedures.
   v. Coordination with other work.
   w. Required performance results.
   x. Protection of adjacent work.
   y. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct Project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
   a. Preparation of record documents.
   b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
   c. Submittal of written warranties.
   d. Requirements for preparing sustainable design documentation.
   e. Requirements for preparing operations and maintenance data.
f. Requirements for demonstration and training.
g. Preparation of Contractor's punch list.
h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
i. Submittal procedures.
j. Coordination of separate contracts.
k. Owner's partial occupancy requirements.
l. Installation of Owner's furniture, fixtures, and equipment.
m. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at agreed upon intervals.
1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner, Owner’s Commissioning Authority, Construction Manager, and Architect, each contractor, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
   a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      1) Review schedule for next period.
   b. Review present and future needs of each entity present, including the following:
      1) Interface requirements.
      2) Sequence of operations.
      3) Status of submittals.
      4) Deliveries.
      5) Off-site fabrication.
      6) Access.
      7) Site utilization.
      8) Temporary facilities and controls.
      9) Progress cleaning.
     10) Quality and work standards.
     11) Status of correction of deficient items.
     12) Field observations.
     13) Status of RFIs.
     14) Status of proposal requests.
     15) Pending changes.
     16) Status of Change Orders.
     17) Pending claims and disputes.
     18) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

F. Coordination Meetings: Conduct Project coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.
1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
   a. Combined Contractor's Construction Schedule: Review progress since the last coordination
meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.

c. Review present and future needs of each contractor present, including the following:
   1) Interface requirements.
   2) Sequence of operations.
   3) Status of submittals.
   4) Deliveries.
   5) Off-site fabrication.
   6) Access.
   7) Site utilization.
   8) Temporary facilities and controls.
   9) Work hours.
   10) Hazards and risks.
   11) Progress cleaning.
   12) Quality and work standards.
   13) Change Orders.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Contractor's construction schedule.
   2. Daily construction reports.
   3. Material location reports.
   4. Field condition reports.
   5. Special reports.

1.3 DEFINITIONS
A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
   1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
   2. Predecessor Activity: An activity that precedes another activity in the network.
   3. Successor Activity: An activity that follows another activity in the network.
B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of the Project.
C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
D. Event: The starting or ending point of an activity.
E. Float: The measure of leeway in starting and completing an activity.
   1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
   2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
   3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
F. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS
A. Format for Submittals: Submit required submittals in the following format:
   1. PDF electronic file.
B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
   1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
C. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
   1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
   2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
   3. Total Float Report: List of all activities sorted in ascending order of total float.
   4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until
most recent Application for Payment.
D. Material Location Reports: Submit at prior to application for payment.
E. Field Condition Reports: Submit at time of discovery of differing conditions.
F. Special Reports: Submit at time of unusual event.

1.5 QUALITY ASSURANCE
A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.

1.6 COORDINATION
A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
B. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
   1. Secure time commitments for performing critical elements of the Work from entities involved.
   2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL
A. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.
   1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
B. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
   1. Procurement Activities: Include procurement process activities for long lead items (as identified by Contractor) and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
   2. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
   3. Startup and Testing Time: Include not less than 15 days for startup and testing.
   4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
   5. Punch List and Final Completion: Include not more than 30 days for punch list and final completion.
C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
   1. Phasing: Arrange list of activities on schedule by phase.
   2. Work under More Than One Contract: Include a separate activity for each contract.
   3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
   4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
   5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
   6. Work Restrictions: Show the effect of the following items on the schedule:
      a. Coordination with existing construction.
      b. Limitations of continued occupancies.
      c. Uninterruptible services.
      d. Partial occupancy before Substantial Completion.
      e. Use of premises restrictions.
      g. Seasonal variations.
      h. Environmental control.
   7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
2.2 CONTRACTOR’S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Start-up Network Diagram: Submit diagram within 14 days of date established for commencement of the Work. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor’s construction schedule using a cost- and resource-loaded, time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for commencement of the Work.
   a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect’s approval of the schedule.
   2. Conduct educational workshops to train and inform key Project personnel, including subcontractors’ personnel, in proper methods of providing data and using CPM schedule information.
   3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
   4. Use “one workday” as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to correlate with Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the start-up network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
   a. Preparation and processing of submittals.
b. Mobilization and demobilization.
c. Purchase of materials.
d. Delivery.
e. Fabrication.
f. Utility interruptions.
g. Installation.
h. Work by Owner that may affect or be affected by Contractor's activities.
i. Testing and commissioning.
j. Punch list and final completion.
k. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.

3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.

4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
   a. Sub-networks on separate sheets are permissible for activities clearly off the critical path.

5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
   a. Each activity cost shall reflect an appropriate value subject to approval by Architect.
   b. Total cost assigned to activities shall equal the total Contract Sum.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
   1. Contractor or subcontractor and the Work or activity.
   2. Description of activity.
   3. Principal events of activity.
   4. Immediate preceding and succeeding activities.
   5. Early and late start dates.
   6. Early and late finish dates.
   7. Activity duration in workdays.
   8. Total float or slack time.
   10. Dollar value of activity (coordinated with the schedule of values).

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
   1. Identification of activities that have changed.
   2. Changes in early and late start dates.
   3. Changes in early and late finish dates.
   5. Changes in the critical path.
   6. Changes in total float or slack time.

H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
   1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
   2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
   3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
   4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
      a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
      b. Submit value summary printouts one week before each regularly scheduled progress meeting.
2.3 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (refer to special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Unusual events (refer to special reports).

B. Material Location Reports: prepare and submit a comprehensive list of materials delivered to and stored at Project site. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor’s personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR’S CONSTRUCTION SCHEDULE

A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.

B. Contractor’s Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

C. Distribution: Distribute copies of approved schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the

CONSTRUCTION PROGRESS DOCUMENTATION
013200 - 5
Work and are no longer involved in performance of construction activities.

END OF SECTION
SECTION 013233
PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for the following:
   1. Pre-construction photographs.
   2. Periodic construction photographs.
   3. Final completion construction photographs.

1.3 INFORMATIONAL SUBMITTALS
A. Digital Photographs: Submit image files within three days of taking photographs.
   1. Digital Camera: Minimum sensor resolution of 8 megapixels.
   2. Format: Minimum 1600 by 1200 pixels, 400 dpi minimum, in unaltered original files, with same aspect ratio as the sensor, un-cropped, date- and time- stamped, in folder named by date of photograph, accompanied by key plan file.
   3. Identification: Provide the following information with each image description in file metadata tag:
      a. Name of Project.
      b. Name of Architect.
      c. Name of Contractor.
      d. Date photograph was taken.
      e. Description of location, direction (by compass point), and elevation or story of construction.

1.4 COORDINATION
A. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested including access to Project site and use of temporary facilities, including temporary lighting required to produce clear, well-lit photographs.

1.5 USAGE RIGHTS
A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA
A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 1600 by 1200 pixels and 400 dpi.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS
A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
   1. Maintain key plan with each set of construction photographs that identifies each photographic location.
B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
   1. Date and Time: Include date and time in file name for each image.
   2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.
C. Pre-construction Photographs: Before commencement of excavation, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
   1. Flag construction limits before taking construction photographs.
2. Take a minimum of 40 photographs and videos as directed by the Architect to show existing conditions adjacent to property before starting the Work.
3. Take a minimum of 40 photographs and videos as directed by the Architect of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

D. Periodic Construction Photographs: Take a minimum of 20 photographs monthly (or a mutually agreed number), coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

E. Time-Lapse Sequence Construction Photographs: Take photographs as indicated, to show status of construction and progress since last photographs were taken.
   1. Frequency: Take photographs weekly, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment.
   2. Vantage Points: Following suggestions by Architect and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than two of the required shots from same vantage point each time to create a time-lapse sequence as follows:
      a. Commencement of the Work, through completion of subgrade construction.
      b. Above-grade structural framing.
      c. Exterior building enclosure.
      d. Interior Work, through date of Substantial Completion.
SECTION 013300
SUBMITTAL PROCEDURES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.3 DEFINITIONS
A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as action submittals.
B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as informational submittals.
C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

1.4 ACTION SUBMITTALS
A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or modifications to submittals noted by the Architect and additional time for handling and reviewing submittals required by those corrections.
   1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
   2. Initial Submittal: Submit concurrently with start-up construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead-time for manufacture or fabrication.
   3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
   4. Format: Arrange the following information in a tabular format:
      a. Scheduled date for first submittal.
      b. Specification Section number and title.
      c. Submittal category: Action, informational.
      d. Name of subcontractor.
      e. Description of the Work covered.
      f. Scheduled date for Architect's final release or approval.
      g. Scheduled dates for purchasing.
      h. Scheduled dates for installation.
      i. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS
A. Architect's Digital Data Files: Electronic copies of CAD Drawings will be provided by Architect for Contractor's use in preparing coordination submittals.
1. Architect will furnish Contractor one set of drawing files for use in preparing Shop Drawings and Project record drawings.
2. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
4. Contractor shall execute a data licensing agreement in the form of Agreement included in Project Manual.
5. The following CAD files will be furnished for each appropriate discipline: AE floor, finish, reflected ceiling and site plans.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are approved by Architect.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
5. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals. Submittals received after 1:00 pm will be considered to have been received the following day.
1. Allow 10 business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination. Allow 4-week review time for large or complex submittals that will require additional review time. The following are examples but not limited to such submittals, Millwork, Curtain Wall, Structural Steel, Grade Beams, Doors Frames Hardware (total opening).
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 10 business days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 20 business days for initial review of each submittal.

D. Identification and Information: Place a permanent label or title block on each copy submittal item for identification.
1. On large format Shop Drawings, Contractor shall stamp each individual page as well as the reviewer's stamp.
2. Indicate name of firm or entity that prepared each submittal on label or title block.
3. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
4. Include the following information for processing and recording action taken:
   a. Project name.
   b. Date.
   c. Name of Architect.
   d. Name of Contractor.
   e. Name of subcontractor.
   f. Name of supplier.
   g. Name of manufacturer.
   h. Submittal number or other unique identifier, including revision identifier.
      i. Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
   j. Number and title of appropriate Specification Section.
   k. Drawing number and detail references, as appropriate.
   l. Location(s) where product is to be installed, as appropriate.
   m. Other necessary identification.

E. Identification and Information: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.

2. Name file with submittal number or other unique identifier, including revision identifier.
   a. For typical projects that do not require separate submittals for different buildings or sub the submittal file name shall use Specification Section number followed by a dash and then a sequential number. Resubmittals shall include a numerical suffix after another dash. Include brief description of submittal after sequential number or resubmittal suffix. (e.g., 061000-001-0 Rough Carpentry).
   b. For complex projects that require project identifier for separate buildings within a project or require individual submittals to be submitted by multiple subcontractors, the submittal file name shall follow the following. Specification Section number followed by a decimal point and then a sequential number. Resubmittals shall include an alphabetic suffix after another decimal point. Project Identifier should follow in parentheses (e.g., 061000-001-0 (LNHS) Rough Carpentry).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.

4. Include the following information on an inserted cover sheet:
   a. Project name.
   b. Date.
   c. Name and address of Architect.
   d. Name of Contractor.
   e. Name of firm or entity that prepared submittal.
   f. Name of subcontractor.
   g. Name of supplier.
   h. Name of manufacturer.
   i. Number and title of appropriate Specification Section.
   j. Drawing number and detail references, as appropriate.
   k. Location(s) where product is to be installed, as appropriate.
   l. Related physical samples submitted directly.
   m. Other necessary identification.

5. Include the following information as keywords in the electronic file metadata:
   a. Project name.
   b. Number and title of appropriate Specification Section.
   c. Manufacturer name.
   d. Product name.

F. Options: Identify options requiring selection by the Architect.

G. Deviations: Identify deviations from the Contract Documents on submittals.

H. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
   a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.

I. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review, received from sources other than Contractor.
   1. Transmittal Form: Use standard contractor form as approved by Architect Owner.
   2. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

J. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
   1. Note date and content of previous submittal.
   2. Note date and content of revision in label or title block and clearly indicate extent of revision.
   3. Include all submitted information from previous submittal in resubmittal, to form a comprehensive document for Architect's review.
   4. Resubmit submittals until they are marked with 'Reviewed', 'Furnish as Corrected' notation from Architect's action stamp, or with approval notation from alternate reviewer.

K. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, and installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

L. Use for Construction: Use only final submittals that are marked with ‘Reviewed’, ‘Furnish as Corrected’ notation from Architect’s action stamp, or with approval notation from alternate reviewer.
PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Email or upload electronic submittals as PDF electronic files directly to Architect’s Info Exchange Folder (Newforma) specifically established for Project.

2. Action Submittals: For large format drawings and submittals (larger than 11 x 17), submit PDF file plus 2 hard copies. For smaller format drawings and submittals (11x17 or less), provide only PDF file. Architect will return only the marked-up PDF.

3. Informational Submittals: Submit two paper copies of each submittal, unless otherwise indicated. Architect will not return copies.

4. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section “Closeout Procedures.”

5. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
   a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
   b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

6. Test and Inspection Reports Submittals: Comply with requirements specified in Division 01 Section “Quality Requirements.”

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:
   a. Manufacturer's catalog cuts.
   b. Manufacturer's product specifications.
   c. Standard color charts.
   d. Statement of compliance with specified referenced standards.
   e. Testing by recognized testing agency.
   f. Application of testing agency labels and seals.
   g. Notation of coordination requirements.
   h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:
   a. Wiring diagrams showing factory-installed wiring.
   b. Printed performance curves.
   c. Operational range diagrams.
   d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.

6. Submit Product Data in the following format:
   a. PDF electronic file.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Identification of products.
   b. Schedules.
   c. Compliance with specified standards.
   d. Notation of coordination requirements.
   e. Notation of dimensions established by field measurement.
   f. Relationship and attachment to adjoining construction clearly indicated.
   g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.

3. Submit Shop Drawings in the following format:
4. For large format drawings and submittals (larger than 11 x 17), submit PDF file plus 1 hard copy. For smaller format drawings and submittals (11x17 or less), provide only PDF file. Architect will return only the marked-up PDF.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Identification: Attach label on unexposed side of Samples that includes the following:
   a. Generic description of Sample.
   b. Product name and name of manufacturer.
   c. Sample source.
   d. Number and title of applicable Specification Section.

3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
   a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
   b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
   a. Number of Samples: Submit three full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
   a. Number of Samples: Submit sets of Samples. Architect will retain one sample set; remainder will be returned. Mark up and retain one returned Sample set as a Project record sample.

   1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.

   2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
   1. Type of product. Include unique identifier for each product indicated in the Contract Documents.
   2. Manufacturer and product name, and model number if applicable.
   3. Number and name of room or space.
   4. Location within room or space.
   5. Submit product schedule in the following format:
      a. PDF electronic file.

F. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."

G. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."

H. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."

I. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A. Include the following information in tabular form:
   1. Name, address, and telephone number of entity performing subcontract or supplying products.
   2. Number and title of related Specification Section(s) covered by subcontract.
   3. Drawing number and detail references, as appropriate, covered by subcontract.
   4. Submit subcontract list in the following format:
a. PDF electronic file.

J. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."

K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.


M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

R. Product Test Reports: Submit written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
   1. Name of evaluation organization.
   2. Date of evaluation.
   3. Time period when report is in effect.
   4. Product and manufacturers' names.
   5. Description of product.
   6. Test procedures and results.
   7. Limitations of use.

T. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section "Quality Requirements."

U. Pre-construction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

W. Field Test Reports: Submit reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

X. Maintenance Data: Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."

Y. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally-signed PDF electronic file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR’S REVIEW
   A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
   B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Division 01 Section “Closeout Procedures.”
   C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor’s approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT’S ACTION
   A. General: Architect will not review submittals that do not bear Contractor’s approval stamp and will return them without action.
   B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:
      1. Reviewed
      2. Revise and Resubmit
      3. Rejected
      4. Furnish As Corrected
      5. No Action Taken.
   C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
   D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
   E. Incomplete submittals are not acceptable, will be considered non-responsive, and will be returned without review.
   F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION
SECTION 014000
QUALITY REQUIREMENTS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for quality assurance and quality control.
B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor’s other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
C. Related Sections:
1. Divisions 02 through 49 Sections for specific test and inspection requirements.

1.3 DEFINITIONS
A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
1. Laboratory Mockups: Full-size, physical assemblies constructed at testing facility to verify performance characteristics.
2. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on the project site, consisting of multiple products, assemblies and subassemblies.
3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.
D. Pre-construction Testing: Tests and inspections performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
F. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements...
specified apply exclusively to specific trade or trades.

J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS
A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.
B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 ACTION SUBMITTALS
A. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
1. Indicate manufacturer and model number of individual components.
2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS
A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
B. Contractor's Quality-Control Manager Qualifications: For supervisory personnel.
C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN
A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to pre-construction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project. Project quality-control manager may also serve as Project superintendent.
C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
D. Testing and Inspection: Include in quality-control plan a comprehensive schedule of Work requiring testing or inspection, including the following:
1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
3. Owner-performed tests and inspections indicated in the Contract Documents.
E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS
A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.
B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.
C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.
D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.9 QUALITY ASSURANCE
A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind...
QUALITY REQUIREMENTS

indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Pre-construction Testing: Where testing agency is indicated to perform pre-construction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:
   a. Provide test specimens representative of proposed products and construction.
   b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
   c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
   d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
   e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
   f. When testing is complete, remove test specimens, assemblies, mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
2. Notify Architect 7 days in advance of dates and times when mockups will be constructed.
3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at the Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
   a. Allow seven days for initial review and each re-review of each mockup.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed, unless otherwise indicated.

L. Integrated Exterior Mockups: Construct integrated exterior mockup in accordance with approved Shop Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual specification sections, along with supporting materials.

1.10 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
   1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
   2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
      a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
   3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
   4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Re-testing/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

   1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
   3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
   6. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
   4. Facilities for storage and field curing of test samples.
   5. Delivery of samples to testing agencies.
   6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.11 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
   1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and
QUALITY REQUIREMENTS

reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and re-inspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG
   A. Prepare a record of tests and inspections. Include the following:
      1. Date test or inspection was conducted.
      2. Description of the Work tested or inspected.
      3. Date test or inspection results were transmitted to Architect.
      4. Identification of testing agency or special inspector conducting test or inspection.
   B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 REPAIR AND PROTECTION
   A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
      1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Division 01 Section "Execution."
   B. Protect construction exposed by or for quality-control service activities.
   C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION
REFERENCEs

PART 1 - GENERAL

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

1.2 DEFINITIONS
A. General: Basic Contract definitions are included in the Conditions of the Contract.
B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
H. "Provide": Furnish and install, complete and ready for the intended use.
I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS
A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS
A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the United States."

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION – Not Used

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

1.3 USE CHARGES
A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's own forces, Architect, testing agencies, and authorities having jurisdiction.
B. Sewer Service: Owner will pay sewer service use charges for sewer usage by all entities for construction operations.
C. Water Service: Owner will pay water service use charges for water used by all entities for construction operations.
D. Electric Power Service: Owner will pay electric power service use charges for electricity used by all entities for construction operations.
E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS
A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
C. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage, including delivery, handling, and storage provisions for materials subject to water absorption or water damage, discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water damaged Work. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
D. Dust-Control and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust-control and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
   1. Locations of dust-control partitions at each phase of the work.
   2. HVAC system isolation schematic drawing.
   3. Location of proposed air filtration system discharge.
   4. Other dust-control measures.
   5. Waste management plan.

1.5 QUALITY ASSURANCE
A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

1.6 PROJECT CONDITIONS
A. Temporary Use of Permanent Facilities: Engage installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top rails.

B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top and bottom rails. Provide galvanized steel bases for supporting posts.

C. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10 mils minimum thickness, with flame-spread rating of 15 or less per ASTM E 84.

D. Dust Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches.

E. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

F. Temporary Sound Control Partitions: Refer to section 092216 “Non-Structural Metal Framing,” section 092900 “Gypsum Board” and section 098116 “Acoustical Blanket Insulation” minimum 51 STC.

2.2 TEMPORARY FACILITIES
A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, Construction Manager, and construction personnel office activities and to accommodate project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with not less than 1 receptacle on each wall. Furnish room with conference table, chairs, and 4-foot-square tack and marker boards.
3. Drinking water and private toilet.
5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
6. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.

C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
1. Store combustible materials apart from building.

2.3 EQUIPMENT
A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction and clean HVAC system as required in Division 01 Section “Closeout Procedures”.

C. Air Filtration Units: HEPA primary and secondary filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.
PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL
A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
   1. Locate facilities to limit site disturbance as specified in Division 01 Section “Summary.”
B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION
A. General: Install temporary service or connect to existing service.
   1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
   1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
D. Water Service: Connect to Owner’s existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
   1. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
F. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
G. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
   1. Prior to commencing work, isolate the HVAC system in area where work is to be performed in accordance with approved coordination drawings.
      a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
      b. Maintain negative air pressure within work area using HEPA-equipped air filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
   2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust containment devices.
   3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
H. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
   1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
I. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
J. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
   1. Install electric power service overhead, unless otherwise indicated.
   2. Connect temporary service to Owner's existing power source, as directed by Owner.
K. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
2. Install lighting for Project identification sign.

L. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line(s) for each field office.
   1. Provide additional telephone lines for the following:
      a. Provide a dedicated telephone line for each facsimile machine in each field office.
      b. Provide one telephone line(s) for Owner's use.
   2. At each telephone, post a list of important telephone numbers.
      a. Police and fire departments.
      b. Ambulance service.
      c. Contractor's home office.
      d. Architect's office.
      e. Engineers' offices.
      f. Owner's office.
      g. Principal subcontractors' field and home offices.

2. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

M. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access project electronic documents and maintain electronic communications. Equip computer with not less than the following:
   1. Processor: Intel Pentium D or Intel CoreDuo, 1.8 GHz processing speed.
   2. Memory: 2 gigabyte.
   4. Display: 19-inchLCD monitor with 128 Mb dedicated video RAM.
   5. Full-size keyboard and mouse.
   8. Productivity Software:
      a. Microsoft Office Professional, XP or higher, including Word, Excel, and Outlook.
      b. Adobe Reader 7.0 or higher.
      c. WinZip 7.0 or higher.
   9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these 3 functions.
   10. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 384 Kbps upload and 1 Mbps download speeds at each computer.
   11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing and spam protection in a combined application.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:
   1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
   2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
   1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
   2. Prepare subgrade and install sub-base and base for temporary roads and paved areas according to Division 31 Section "Earth Moving."
   3. Recondition base after temporary use, including removing contaminated material, re-grading, proofrolling, compacting, and testing.

C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
   1. Protect existing site improvements to remain including curbs, pavement, and utilities.
   2. Maintain access for fire-fighting equipment and access to fire hydrants.

D. Parking: Provide temporary parking areas for construction personnel.

E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
   a. Provide temporary, directional signs for construction personnel and visitors.
3. Maintain and touchup signs so they are legible at all times.

G. Waste Disposal Facilities: Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."

H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

I. Temporary Elevator Use: Refer to Division 14 Sections for temporary use of new elevators.

J. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

K. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
   1. Comply with work restrictions specified in Division 01 Section "Summary."

B. Temporary Erosion and Sedimentation Control: Comply with requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Division 31 Section “Site Clearing.”

C. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

D. Tree and Plant Protection: Comply with requirements specified in Division 01 Section “Temporary Tree and Plant Protection.”

E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.

F. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
   1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
   2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.

G. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.

H. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

I. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

J. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather-tight enclosure for building exterior.
   1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

K. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
   1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant plywood on construction operations side.
   2. Construct dustproof partitions with two layers of 6-milpolyethylene sheet on each side. Cover floor with two layers of 6-milpolyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant treated plywood.
a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.

3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.

4. Insulate partitions to control noise transmission to occupied areas.

5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.

6. Protect air-handling equipment.

7. Provide walk-off mats at each entrance through temporary partition.

L. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.

1. Prohibit smoking in construction areas.

2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.

3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 MOISTURE AND MOLD CONTROL

A. Contractor’s Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.

2. Protect stored and installed materials from flowing or standing water.

3. Keep porous and organic materials from coming into prolonged contact with concrete.

4. Remove standing water from decks.

5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.

2. Keep interior spaces reasonably clean and protected from water damage.

3. Periodically collect and remove waste containing cellulose or other organic matter.

4. Discard or replace water-damaged material.

5. Do not install material that is wet.

6. Discard, replace or clean stored or installed material that begins to grow mold.

7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.

2. Use permanent HVAC system to control humidity.

3. Comply with manufacturer’s written instructions for temperature, relative humidity, and exposure to water limits.

   a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.

   b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record daily readings over a forty-eight hour period. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.

   c. Remove materials that can not be completely restored to their manufactured moisture level within 48 hours.
3.6 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.
   1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
   1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
   2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION
SECTION 015300

MOLD PREVENTION MEASURES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes: Administrative and procedural requirements to help prevent mold contamination in construction.

1.3 SUBMITTALS
A. Reports: Submit reports required in this Section, including but not limited to the following:
   1. Sightings of existing mold.
   2. Window and storefront testing.
   4. Exterior sealant cracks, damage, and deterioration.

1.4 QUALITY ASSURANCE
A. Pre-construction Meeting: Review requirements of this Section at Pre-construction Meeting.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
B. Do not bring finish materials into building until building is in a conditioned state. Protect finish materials stored within building. Stage materials off the floor and cover with waterproof covering. Examples of these materials include, but are not limited to, insulation, gypsum products, wall coverings, carpet, ceiling tile, wood products, etc.
C. Remove from Project site damaged materials or materials that have become wet. Do not install such materials.

1.6 PROJECT CONDITIONS
A. Perform daily visual inspections of existing building for existing mold. Report sightings of mold to Architect.
B. Remove water found within building during construction immediately.
   1. Energize lift stations and sump pumps as early in Project as possible. Use temporary pumps if necessary to get water out of building and drain lines.
C. Ventilation:
   1. Verify that existing HVAC system is providing positive pressure in building.
   2. Provide adequate air circulation and ventilation during demolition phase(s).
   3. Seal off return air ducts and diffusers to prevent construction dust and moisture from entering occupied areas and HVAC system.
   4. Provide temporary outside air ventilation as building becomes enclosed.
D. Maintain clean project site, free from hazards, garbage, and debris.
E. Eating, drinking, and smoking are not permitted within building.
F. Slope perimeter grades, both temporary and final grades, away from building structure.
G. Verify that condensate pans drain properly beginning with initial installation.
H. Flash roof penetrations immediately. Do not allow water to penetrate to floor below.
I. Seal window openings prior to window installation with plastic to prevent moisture entry.
J. Sprayed-on Fireproofing: Keep air moving throughout building when using sprayed-on fireproofing.
K. Cover stored and installed ductwork and installed duct openings with plastic to prevent dust, debris, and moisture from entering ductwork. Repair damaged plastic barrier.
L. Do not operate air handling equipment below 60 degrees F supply air temperature until building is 100 percent enclosed.
M. Monitor humidity and temperature for conformance to installation requirements defined by material and equipment manufacturers.
N. Check moisture content of gypsum board prior to applying finishes. Record findings.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Roof Drains: Connect roof drains to risers and storm drainage lines as soon as possible.
   B. Floor Drains: Connect floor drains as soon as possible. Do not cover floor drains with tape or other obstructions during construction. Clean out floor drain lines to mains prior to Substantial Completion.
   C. Wall Assemblies:
      1. Install exterior wall insulation, vapor retarder, and gypsum board only after building is enclosed.
      2. Keep bottom of installed gypsum board off floor 1/2 inch.
   D. Cavity Conditions: Clean and inspect cavity conditions prior to covering, sealing, or restricting access. Vacuum clean cavity spaces prior to covering or enclosing.
   E. Sprayed-On Fireproofing: Remove sprayed-on fireproofing overspray immediately.
   F. Plumbing: Pressure test plumbing piping identified as insulated on Project prior to installation of insulation.
   G. Roof Mounted Equipment: Inspect rooftop units and other roof-mounted equipment for signs of rain leaks immediately after first rain. Water test with hose immediately after installation. Seal leaks immediately.
   H. Windows and Storefront: Water test windows to manufacturer’s and Project Manual’s specifications. Record findings and forward to Architect.
   I. Sealants: Inspect exterior sealants for cracks, damage, or deterioration. Record findings and forward to Architect.
   J. HVAC Equipment (Permanent HVAC Equipment Used for Temporary Conditioning of Building During Construction Phases): Change filters and clean ductwork interior to remove dirt, dust, debris, and moisture buildup prior to turning Project over to Owner.

3.2 ADJUSTING
   A. Remove damaged materials or materials that have become wet. Replace with new materials.

3.3 DEMONSTRATION
   A. Train and educate Owner’s maintenance personnel on use of building systems. Explain how improper operation and shutting down systems during off periods can create mold problems.
   B. Schedule with Owner a review of building for mold problems at 1 year warranty walk-through. Inspect exterior sealants and masonry joints for cracks and other damage or deterioration where water can penetrate building envelope.
   C. Explain to Owner the need for Owner to establish annual building review for mold.

END OF SECTION
SECTION 016000

PRODUCT REQUIREMENTS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

1.3 DEFINITIONS
A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
1. 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. Products salvaged from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process 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. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS
A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. Form of Approval: As specified in Division 01 Section "Submittal Procedures."
   b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
B. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE
A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer’s written instructions.

B. Delivery and Handling:
   1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. 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.
   4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:
   1. Store products to allow for inspection and measurement of quantity or counting of units.
   2. Store materials in a manner that will not endanger Project structure.
   3. Store products that are subject to damage by the elements, under cover in a weather-tight enclosure above ground, with ventilation adequate to prevent condensation.
   4. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
   5. Comply with product manufacturer’s written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
   6. Protect stored products from damage and liquids from freezing.
   7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner’s construction forces. Coordinate location with Owner.

1.7 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.
   1. Manufacturer’s Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
   1. Manufacturer’s Standard Form: Modified to include Project-specific information and properly executed.
   2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
   3. Refer to Divisions 02 through 49. Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 01 Section “Closeout Procedures.”

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
   2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
   4. Where products are accompanied by the term “as selected,” Architect will make selection.
   6. Or Equal: For products specified by name and accompanied by the term “or equal,” or “or approved equal,” or “or approved,” comply with requirements in “Comparable Products” Article to obtain approval for use of an unnamed product.

PRODUCT REQUIREMENTS
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7. Where all other criteria are met, contractor shall give preference to products that:
   a. Are extracted, harvested and/or manufactured closer to the project location.
   b. Have longer warranted life span under normal use.
   c. Result in less construction waste.
   d. Have recycled content.

8. Do not use the following products:
   a. Products containing CFCs or HCFCs.
   b. Composite wood products containing added urea formaldehyde.
   c. Wood products harvested from old growth timber.
   d. Paints, coatings, adhesives and sealants for use on the building interior that do not comply
      with requirements of Authority Having Jurisdiction.

B. Product Selection Procedures:
   1. Product: Where Specifications name a single manufacturer and product, provide the named
      product that complies with requirements. Comparable products or substitutions for Contractor's
      convenience will not be considered.
   2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a
      product by the named manufacturer or source that complies with requirements. Comparable
      products or substitutions for Contractor's convenience will not be considered.
   3. Products:
      a. Restricted List: Where Specifications include a list of names of both manufacturers and
         products, provide one of the products listed that complies with requirements. Comparable
         products or substitutions for Contractor's convenience will be considered, unless otherwise
         indicated.
      b. Non-restricted List: Where Specifications include a list of names of both available
         manufacturers and products, provide one of the products listed, or an unnamed product,
         that complies with requirements. Comply with requirements in "Comparable Products"
         Article for consideration of an unnamed product.
   4. Manufacturers:
      a. Restricted List: Where Specifications include a list of manufacturers' names, provide a
         product by one of the manufacturers listed that complies with requirements. Comparable
         products or substitutions for Contractor's convenience will be considered, unless otherwise
         indicated.
      b. Non-restricted List: Where Specifications include a list of available manufacturers, provide a
         product by one of the manufacturers listed, or a product by an unnamed manufacturer, that
         complies with requirements. Comply with requirements in "Comparable Products"
         Article for consideration of an unnamed manufacturer's product.
   5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on
      Drawings, and include a list of manufacturers, provide the specified or indicated product or a
      comparable product by one of the other named manufacturers. Drawings and Specifications
      indicate sizes, profiles, dimensions, and other characteristics that are based on the product named.
      Comply with requirements in "Comparable Products" Article for consideration of an unnamed
      product by one of the other named manufacturers.

C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product
   that complies with requirements and matches Architect's sample. Architect's decision will be final on
   whether a proposed product matches.
   1. If no product available within specified category matches and complies with other specified
      requirements, comply with requirements in Division 01 Section "Substitution Procedures" for
      proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from
   manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect
   will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both
   standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when
   the following conditions are satisfied. If the following conditions are not satisfied, Architect may return
   requests without action, except to record noncompliance with these requirements:
   1. Evidence that the proposed product does not require 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.
   2. Detailed comparison of significant qualities of proposed product with those named in the
      Specifications. Significant qualities include attributes such as performance, weight, size, durability,
LEED requirements, 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.

PART 3 - EXECUTION (Not Used)

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
   2. Field engineering and surveying.
   3. Installation of the Work.
   4. Cutting and patching.
   5. Coordination of Owner-installed products.
   6. Progress cleaning.
   7. Starting and adjusting.
   8. Protection of installed construction.

1.3 DEFINITIONS
A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For land surveyor.
B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
C. Certified Surveys: Submit two copies signed by land surveyor.
D. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.
   1. Format: Pdf and Dwg files required.

1.5 QUALITY ASSURANCE
A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
   1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from the Architect before proceeding. Shore, brace, and support structural element during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
   2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
      a. Primary operational systems and equipment.
      b. Fire separation assemblies.
      c. Air or smoke barriers.
      d. Fire-suppression systems.
      e. Mechanical systems piping and ducts.
      f. Control systems.
      g. Communication systems.
      h. Conveying systems.
      i. Electrical wiring systems.
      j. Operating systems of special construction.
      k. Windows 7 Professional.
3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
   a. Water, moisture, or vapor barriers.
   b. Membranes and flashings.
   c. Exterior curtain-wall construction.
   d. Equipment supports.
   e. Piping, ductwork, vessels, and equipment.
   f. Noise- and vibration-control elements and systems.
   g. Glass or glazing.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

C. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

1.6 WARRANTY
A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS
A. General: Comply with requirements specified in other Sections.

   1. For projects requiring compliance with sustainable design and construction practices and procedures, utilize products for patching that comply with requirements of Division 01 Section "Sustainable Design Requirements."

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

   1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to the Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

   1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
   2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

   1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

      a. Description of the Work.
      b. List of detrimental conditions, including substrates.
      c. List of unacceptable installation tolerances.
      d. Recommended corrections.

   2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or
3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION
A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
B. Field Measurements: Take field measurements as required to fit the Work properly. Re-check measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of the Contractor, submit a request for information to Architect according to requirements in Division 01 Section "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT
A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
   1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
   2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
   3. Inform installers of lines and levels to which they must comply.
   4. Check the location, level and plumb, of every major element as the Work progresses.
   5. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
   6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING
A. Identification: Owner will identify existing benchmarks, control points, and property corners.
B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
   1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
   2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
   1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

E. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
   1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
   2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION
A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
G. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CUTTING AND PATCHING
A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
B. Temporary Support: Provide temporary support of work to be cut.
C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
D. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements of Division 01 Section "Summary."
E. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required
to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

F. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer’s written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.

5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.

6. Proceed with patching after construction operations requiring cutting are complete.

G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.

2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
   a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
   b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
   a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or re-hang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather-tight condition.

H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction personnel.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.

2. Pre-installation Conferences: Include Owner's construction personnel at pre-installation conferences covering portions of the Work that are to receive Owner's work. Attend pre-installation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.


2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
a. Utilize containers intended for holding waste materials of type to be stored.
4. Coordinate progress cleaning for joint-use areas where more than one installer has worked.

B. Site: Maintain Project site free of waste materials and debris.
C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Section "Temporary Facilities and Controls." Division 01 Section "Construction Waste Management and Disposal."
H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.9 STARTING AND ADJUSTING
A. Coordinate startup and adjusting of equipment and operating components with requirements in Division 01 Section "General Commissioning Requirements."
B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
E. Manufacturer's Field Service: Comply with qualification requirements in Division 01 Section "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION
A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.11 CORRECTION OF THE WORK
A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
   1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
B. Restore permanent facilities used during construction to their specified condition.
C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION
SECTION 017700
CLOSEOUT PROCEDURES

PART 1 - GENERAL

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

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

1.3 SUBSTANTIAL COMPLETION
A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete with request.
   1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
   2. Advise Owner of pending insurance changeover requirements.
   3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   5. Prepare and submit Project Record Documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
   6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
   7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   8. Complete startup testing of systems.
   10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   11. Advise Owner of changeover in heat and other utilities.
   12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
   13. Complete final cleaning requirements, including touchup painting.
   14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
   1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for final completion.

1.4 FINAL COMPLETION
A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
   1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
   2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
CLOSEOUT PROCEDURES

4. Submit pest-control final inspection report and warranty.
5. Instruct Owner’s personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
   1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected. Include cost for re-inspection based on incomplete work of the Contractor.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)
A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use form provide by Contractor and approved by Architect.
   1. Organize list of spaces in sequential order, starting with exterior areas first.
   2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
   3. Include the following information at the top of each page:
      a. Project name.
      b. Date.
      c. Name of Architect.
      d. Name of Contractor.
      e. Page number.
   4. Submit list of incomplete items in the following format:
      a. PDF electronic file.

1.6 WARRANTIES
A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
   1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
   2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
   3. Identify each binder on the front and spine with the typed or printed title “WARRANTIES,” Project name, and name of Contractor.
   4. Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide table of contents at beginning of document.
D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
   1. Use cleaning products that meet Green Seal GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.
PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
   a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
   c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   d. Remove tools, construction equipment, machinery, and surplus material from Project site.
   e. Remove snow and ice to provide safe access to building.
   f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
   g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   h. Sweep concrete floors broom clean in unoccupied spaces.
   i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
   j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
   k. Remove labels that are not permanent.
   l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
      1) Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates.
   m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
   n. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
   o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
   p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
   q. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter upon inspection.
   r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
   s. Leave Project clean and ready for occupancy.

C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory.
   2. Emergency manuals.
   3. Operation manuals for systems, subsystems, and equipment.
   4. Product maintenance manuals.
   5. Systems and equipment maintenance manuals.

1.3 DEFINITIONS
A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS
A. Manual Content: Operations and maintenance manual content is specified in individual specification sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
   1. Where applicable, clarify and update reviewed manual content to correspond to modifications and field conditions.
B. Format: Submit operations and maintenance manuals in the following format:
      a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
      b. Enable inserted reviewer comments on draft submittals.
C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.
D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.
   1. Correct or modify each manual to comply with Architect's comments. Submit three (3) copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY
A. Organization: Include a section in the directory for each of the following:
   1. List of documents.
   2. List of systems.
   3. List of equipment.
   4. Table of contents.
B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, “Preparation of Operating and Maintenance Documentation for Building Systems.”

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
   1. Title page.
   2. Table of contents.

B. Title Page: Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name and contact information for Contractor.
   6. Name and contact information for Construction Manager.
   7. Name and contact information for Architect.
   8. Name and contact information for Commissioning Agent.
   9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
   10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
   1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
   2. File Names and Bookmarks: Enable bookmarking of individual documents based upon file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel upon opening file.

F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
   1. Binders: Heavy-duty, three-ring, vinyl-covered, post-type binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
      b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
   2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
   3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
   5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
      a. If oversize drawings are necessary, fold drawings to same size as text pages and use as
foldouts.  

b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 EMERGENCY MANUALS  
A. Content: Organize manual into a separate section for each of the following:  
1. Type of emergency.  
2. Emergency instructions.  
3. Emergency procedures.  
B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:  
1. Fire.  
2. Flood.  
5. Power failure.  
7. System, subsystem, or equipment failure.  
8. Chemical release or spill.  
C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.  
D. Emergency Procedures: Include the following, as applicable:  
1. Instructions on stopping.  
2. Shutdown instructions for each type of emergency.  
3. Operating instructions for conditions outside normal operating limits.  
4. Required sequences for electric or electronic systems.  
5. Special operating instructions and procedures.

2.4 OPERATION MANUALS  
A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:  
2. Performance and design criteria if Contractor is delegated design responsibility.  
3. Operating standards.  
4. Operating procedures.  
5. Operating logs.  
6. Wiring diagrams.  
7. Control diagrams.  
8. Piped system diagrams.  
9. Precautions against improper use.  
10. License requirements including inspection and renewal dates.  
B. Descriptions: Include the following:  
1. Product name and model number. Use designations for products indicated on Contract Documents.  
2. Manufacturer's name.  
3. Equipment identification with serial number of each component.  
4. Equipment function.  
5. Operating characteristics.  
6. Limiting conditions.  
7. Performance curves.  
8. Engineering data and tests.  
9. Complete nomenclature and number of replacement parts.  
C. Operating Procedures: Include the following, as applicable:  
1. Startup procedures.  
2. Equipment or system break-in procedures.  
3. Routine and normal operating instructions.  
4. Regulation and control procedures.  
5. Instructions on stopping.  
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.5 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:
   1. Product name and model number.
   2. Manufacturer's name.
   3. Color, pattern, and texture.
   5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
   1. Inspection procedures.
   2. Types of cleaning agents to be used and methods of cleaning.
   3. List of cleaning agents and methods of cleaning detrimental to product.
   4. Schedule for routine cleaning and maintenance.
   5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
   1. Standard maintenance instructions and bulletins.
   2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   3. Identification and nomenclature of parts and components.
   4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training video recording, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION AND DELIVERY

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.

2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.

2. Comply with requirements of newly prepared record Drawings in Division 01 Section "Project Record Documents."

G. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

H. Include transmittal with all deliveries to Owner. Request receipt confirmation.

END OF SECTION
SECTION 017839

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for project record documents, including the following:
   1. Record Drawings.
   2. Record Specifications.
   3. Record Product Data.
   4. Miscellaneous record submittals.

1.3 CLOSEOUT SUBMITTALS
A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit copies of record Drawings as follows:
      a. Initial Submittal: Submit one paper copy and PDF electronic files of marked-up record prints and one set(s) of plots from corrected record digital data files. Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
      b. Final Submittal: Submit one paper copy and PDF electronic files of marked-up record prints. Print each Drawing, whether or not changes and additional information were recorded.
      c. Final Submittal: Submit one paper copy and PDF electronic files of marked-up record prints, one set(s) of record digital data files, and three set(s) of record digital data file plots. Plot each drawing file, whether or not changes and additional information were recorded.
   B. Record Specifications: Submit one paper copy and one PDF copy of Project's Specifications, including addenda and contract modifications.
   C. Record Product Data: Submit one paper copy and one PDF copy of each submittal. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
   D. Miscellaneous Record Submittals: Refer to other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit one paper copy of each submittal.
   E. Reports: Submit written report indicating items incorporated in Project record documents concurrent with progress of the Work, including modifications, concealed conditions, field changes, product selections, and other notations incorporated.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS
A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings.
   1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
      a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
      b. Accurately record information in an acceptable drawing technique.
      c. Record data as soon as possible after obtaining it.
      d. Record and check the markup before enclosing concealed installations.
      e. Cross-reference record prints to corresponding archive photographic documentation.
   2. Content: Types of items requiring marking include, but are not limited to, the following:
      a. Dimensional changes to Drawings.
      b. Revisions to details shown on Drawings.
c. Depths of foundations below first floor.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order or Construction Change Directive.
k. Changes made following Architect's written orders.
l. Details not on the original Contract Drawings.
m. Field records for variable and concealed conditions.
n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.

4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
2. Format: DWG, Version Autocad 2013, operating in Microsoft Windows operating system.
3. Format: Annotated PDF electronic file with comment function enabled.
4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
5. Refer instances of uncertainty to Architect through Construction Manager for resolution.

C. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.

1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
2. Consult Architect and Construction Manager for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.

D. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:
   a. Project name.
   b. Date.
   c. Designation "PROJECT RECORD DRAWINGS."
   d. Name of Architect and Construction Manager.
   e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a
record of selections made.

4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.

5. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file(s) of marked up paper copy of Specifications.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Include significant changes in the product delivered to Project site and changes in manufacturer’s written instructions for installation.

3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as annotated PDF electronic file paper copy scanned PDF electronic file(s) of marked up paper copy of Product Data.

1. Include record Product Data directory organized by specification section number and title, electronically linked to each item of record Product Data.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file paper copy scanned PDF electronic file(s) of marked up miscellaneous record submittals.

1. Include miscellaneous record submittals directory organized by specification section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and modifications to project record documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect’s and Construction Manager’s reference during normal working hours.

END OF SECTION
SECTION 017900

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
      1. Demonstration of operation of systems, subsystems, and equipment.
      2. Training in operation and maintenance of systems, subsystems, and equipment.
   B. Related Sections:
      1. Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections.

1.3 INFORMATIONAL SUBMITTALS
   A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
      1. Indicate proposed training modules utilizing manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
   B. Qualification Data: For facilitator and instructors in accordance with requirements in quality assurance article below.
   C. Attendance Record: For each training module, submit list of participants and length of instruction time.
   D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 QUALITY ASSURANCE
   A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
   B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
   C. Pre-Instruction Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
      1. Inspect and discuss locations and other facilities required for instruction.
      2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
      3. Review required content of instruction.
      4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION
   A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
   B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
   C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.
PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.
   d. Regulatory requirements.
   e. Equipment function.
   f. Operating characteristics.
   g. Limiting conditions.
   h. Performance curves.

2. Documentation: Review the following items in detail:
   a. Emergency manuals.
   b. Operations manuals.
   c. Maintenance manuals.
   d. Project record documents.
   e. Identification systems.
   f. Warranties and bonds.
   g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Sequences for electric or electronic systems.
   f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Instructions on stopping.
   h. Normal shutdown instructions.
   i. Operating procedures for emergencies.
   j. Operating procedures for system, subsystem, or equipment failure.
   k. Seasonal and weekend operating instructions.
   l. Required sequences for electric or electronic systems.
   m. Special operating instructions and procedures.

5. Adjustments: Include the following:
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.

7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.
8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION
   A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Division 01 Section "Operations and Maintenance Data."
   B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION
   A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
   B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
   C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
      1. Schedule training with Owner, through Construction Manager, with at least seven days’ advance notice.
   D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.
   E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION
SECTION 019114

GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL
1.1 SUMMARY
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1. Division 22 – Plumbing
2. Division 23 – Mechanical
3. Division 26 – Electrical
4. Owner’s Project Requirements (OPR) and Basis of Design (BoD) documents are required. The Owner is responsible for production of the Owner’s Project Requirements (OPR) document. The Commissioning Authority can assist in the development of this document if requested by the Owner. The Basis of Design (BoD) document is produced by the Designers and is intended to describe how the design will support the OPR requirements. The Commissioning Authority will review both documents as part of the design review process and to ensure the design meets the Owner’s requirements.

B. A Design Phase Commissioning Plan is provided in Attachment 1 of this document. The Commissioning Plan will be updated as the project progresses and additional information is finalized.

C. It is of primary concern that all systems and assemblies in the project perform in accordance with the design intent and the Owner's operational needs. The process of assuring that such performance is achieved is referred to as "commissioning."

D. The Commissioning Team will include representatives of the Owner, Design A/E, General Contractor and Installing Subcontractors, Test and Balance Subcontractor, BAS Subcontractor and Commissioning Authority (CxA).

E. Commissioning is a comprehensive and systematic process of verifying that the building systems perform interactively in accordance with the BOD, according to the construction documents and the OPR.
   1. The commissioning process shall encompass and coordinate the equipment and system documentation, equipment start up, field testing, control system calibration, testing and balancing, functional performance testing and training. Commissioning requires cooperation and direct involvement by all parties throughout the construction process.
   2. In addition to fulfilling scheduling and planning requirements, the Contractor is further responsible for documenting the equipment and system installation and operational verification for all systems and assemblies.

F. Commissioning Process Overview: The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
   1. Various sections of the project specifications require equipment start-up, testing, and adjusting services. Requirements for start-up, testing, and adjusting services specified in the Division 01 General Requirements, Division 22 Plumbing, Division 23 Mechanical, and Division 26 Electrical series sections of the specifications are intended to be provided in coordination with the commissioning services and are not intended to duplicate services. The Contractor shall coordinate the work required by individual specification sections with the commissioning services requirements specified herein.
   2. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning and performing product.
   3. The Commissioning Authority (CxA), is not responsible for construction means and methods, job safety, or management function related to commissioning on the jobsite.
   4. Commissioning begins with the selection of the Commissioning authority for the project and the development of the OPR document by the Owner.
   5. Commissioning Plan: The commissioning plan provides guidance in the execution of the commissioning process. The Commissioning Authority will prepare and update the plan. The Specifications will facilitate the execution of the Commissioning Plan. The Commissioning Plan will include as a minimum the following information:
      • A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
      • A listing of specific equipment, appliances or systems to be tested and a description of the tests to be performed.
      • Functions to be tested including, but not limited to, calibrations and economizer control.
      • Conditions under which the test will be performed. Testing shall affirm winter and summer design conditions and full outside air conditions.
      • Measureable criteria for performance.
6. Commissioning during construction begins with a planning meeting followed by a kick-off meeting conducted by the Commissioning Authority where the commissioning process is reviewed with the commissioning team members.

7. Equipment and assembly documentation is submitted to the Commissioning Authority during normal submittals, including detailed start-up procedures and early copies of Operation and Maintenance (O&M) data.

8. The Contractor develops start-up plans for selected equipment with review by the Commissioning Authority. The Commissioning Authority and/or Contractor develop Pre-Functional Checklists (PFCs) to be completed by the Contractor during the installation and start-up processes.

9. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with construction checklists being completed before testing.

10. The Contractor executes and documents the PFCs and perform start-up and initial checkout. The Commissioning Authority documents that the checklists, installation and start-up were completed through spot witnessing and reviewing Contractor's completed PFCs and startup reports.

11. Air and water side Test and Balance is required. The CxA will review the results of the draft TAB Report and provide comments. The TAB report must be approved by the Mechanical Engineer of Record prior to the start of Functional Performance Testing.

12. The Commissioning Authority performs periodic construction observations.

13. The Commissioning Authority develops specific written equipment, system and assembly Functional Performance Test (FPT's) procedures for all commissioned Mechanical and Plumbing equipment. The following functions as a minimum will be tested:
   - All modes as described in the sequences of operation.
   - Redundant or automatic back-up modes.
   - Performance of alarms.
   - Mode of operation upon a loss of power and restoration of power.
   - All economizers shall be functionally tested.
   - HVAC control systems shall be tested to document that they are operating according to the approved plans and specifications.
   - Additional items included in the Functional Performance Test documents provided by the CxA.

14. The Commissioning Authority develops specific written equipment, system and assembly Functional Performance Test (FPT's) procedures for all commissioned Lighting and Daylighting controls and equipment. The following functions as a minimum will be tested:
   - **Sampling of the occupancy sensors is permitted as follows (see the Commissioning Plan for additional information):**
     - If there are (7) occupancy sensors or less, all sensors shall be functionally tested.
     - For systems with more than (7) sensors testing shall be cone for each unique combination of sensor type and space geometry.
     - Where multiples of each unique combination of sensor type and space geometry are provided, not less than 10% but in no case less than (1), of each combination, shall be tested unless the code official or design professional requires a higher percentage to be tested.
     - Where 30% or more of the tested controls fail, all remaining identical combinations shall be tested.
   - **Occupancy Controls shall be tested as follows:**
     - Verify status indicators are correct.
     - The controlled lights turn off or down to the permitted level in the required time.
     - For auto-on occupant sensor controls, the lights turn on to the permitted level when an occupant enters the space.
     - For manual-on occupant sensor controls, the lights turn on only when manually activated.
     - The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.
   - **Time-Switch Controls shall be tested as follows:**
     - Confirm the time switch control is programmed with accurate weekday, weekend and holiday schedules.
     - Verify the correct time and date in the time switch.
     - Verify that any battery back-up is installed and energized.
     - Verify that the override time limit is set for no more than 2 hours.
     - Simulate an occupied condition and verify and document the following:
       - All lights can be turned on and off by their respective area control switch.
       - The switch only operates lighting in the enclosed space in which the switch is located.
Simulate an un-occupied condition and verify and document the following:
- Nonexempt lighting turns off.
- Manual override switch only allows the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.
- Additional testing as specified by the registered design professional.
- For manual-on occupant sensor controls, the lights turn on only when manually activated.
- The lights are not incorrectly turned on by movement in adjacent areas.

- **Daylight Responsive Controls shall be tested as follows:**
  - Control devices have been properly located, field calibrated and set for accurate setpoints and threshold light levels.
  - Daylight controlled lighting loads adjust to light level setpoints in response to available daylight.
  - The locations of calibration equipment are readily accessible only to authorized personnel.

15. The test procedures are executed by the Contractor, under the direction of, and documented by the Commissioning Authority for most equipment.

16. The CxA prepares the Preliminary Cx Report and provides this document to the Owner. The Owner sends the code official a letter of transmittal acknowledging that the building owner has received the Preliminary Commissioning Report. The Preliminary Commissioning Report includes the following information:
   - Itemization of deficiencies found during testing that have not been corrected at the time of the report.
   - Deferred tests that cannot be performed at the time of the report preparation because of climatic conditions.
   - Climatic conditions required for performance of the deferred tests.

17. Only after the Preliminary Cx Report is received by the Owner can the final mechanical inspection be scheduled with the Building Official / AHJ.

18. Items of non-compliance in material, installation or setup are documented by the Commissioning Authority and corrected by the Contractor.

19. Cx is completed and all deficiencies corrected prior to Substantial Completion.

20. The final Cx Report shall submitted by the CxA to the Owner within 90 days of the receipt of certificate of occupancy.

21. The Commissioning Authority reviews the O&M material for clarity, accessibility and completeness.

22. The General Contractor compiles an O&M Manual and provides it to the Owner. The O&M Manual contains the following:
   - Submittal data stating the equipment size and selected options for each piece of equipment requiring maintenance.
   - Manufacturer’s maintenance and operation manuals for each piece of equipment requiring maintenance. Routine maintenance actions are clearly identified.
   - The name and address of at least one qualified service agency for each piece of equipment requiring maintenance.
   - HVAC and service hot water controls system maintenance and calibration information, including wiring diagrams, schematics and control sequence descriptions. Desired or field determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions.
   - Submittal data indicating all selected options for each piece of lighting equipment and lighting controls.
   - Manufacturer’s operation and maintenance manuals for each piece of lighting equipment. Required routine maintenance actions, cleaning and recommended relamping shall be clearly scheduled.
   - A schedule for relamping and recalibrating all lighting controls.
   - A narrative of how each system is intended to operate including setpoints.

23. Commissioning is completed before Substantial Completion, except for trend log monitoring, seasonal testing, and near-warranty end activities.

24. Seasonal or deferred testing and near-warranty-end activities are conducted, as specified.

### 1.2 COMMISSIONING AUTHORITY (CxA)

**A.** The CxA services will be provided by the Owner or sub-contracted by the Architect. The Contractor is responsible to execute the Cx process according to this specification section.

**B.** The CxA for this project will be:

1. Mechanical Systems: TBD
2. Service Water Heating Systems: TBD
3. Electrical / Lighting Systems: TBD
1.3 DESCRIPTION OF WORK INCLUDED

A. The following equipment, systems, assemblies and features will be commissioned utilizing the traditional construction phase commissioning process
   d. New Exhaust Fans.
   e. New BAS system.
   f. Existing Rooftop Package Units with Gas Heating and Electric Cooling.
   g. Existing DX Split Systems with Gas Heating and Electric Cooling.

2. Electrical Systems:
   a. Interior Lighting controls
   b. Interior Daylighting Controls
   c. Exterior Lighting Controls.

3. Service Water Heating
   a. Domestic Water Heaters.
   b. Domestic Hot Water Recirculation Pumps
   c. Domestic Hot Water Controls (including aquastats, controllers, sensors, etc.).

1.3 DEFINITIONS

A. Approval: Acceptance that a piece of equipment, system or issue related to it complies with the Contract Documents.
B. Basis of Design (BOD): Documentation of the primary assumptions and rationale behind design decisions that are made to meet the Owner’s intent and project requirements. The BOD describes the assumptions used for sizing and selecting systems and components; site and environmental conditions or constraints; and other factors that led to decisions (e.g., codes, standards, operating conditions, functional goals, and interior environmental criteria).
C. Building Automation System (BAS): The central building energy management control system.
D. Commissioning (Cx): Commissioning is a systematic process of ensuring that all building systems and assemblies perform interactively according to the Owner’s objectives and requirements. This is achieved by beginning in the design phase and documenting the Owner’s Project Requirements, Basis of Design (BOD) and continuing through construction, acceptance and the warranty period with actual verification of function and performance.
E. Commissioning Authority aka Commissioning Provider (CxA): The professional commissioning consultant, not otherwise associated with the A/E team members, Contractor. The Commissioning Authority directs and coordinates the day-to-day commissioning activities in concert with the Contractor.
F. Commissioning Plan (CxP): The project-specific document prepared by the CxA that describes all aspects of the commissioning process including roles & responsibilities, documentation requirements, and communication structures.
G. Commissioning Team (CxT): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
H. Datalogging: Monitoring flows, currents, status, pressures, etc., of equipment using stand-alone dataloggers separate from the control system.
I. Deferred Tests: tests that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.
J. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the Owner’s objectives).
K. Functional Performance Test (FPT): The written procedures and documentation forms of tests used to guide and record testing. FTPs are composed of repeatable, step-by-step procedures and include the test prerequisites, the test process, the expected outcomes and acceptance criteria. Contractor: Refers to the Contractor, Construction Manager, Builder, and all sub-Contractor and/or authorized representatives.
L. Issues Log: Ongoing record of the issues identified during the commissioning process that require or did not require correction. For each entry the log includes a unique identification number and a short description of the issue. The Commissioning Authority is responsible to maintain the log.
M. Monitoring: The recording of parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of control systems.
N. NETA: International Electrical Testing Association, Inc.
O. Over-written Value: Writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation).
P. Owner: The representative on the Project that has the authority to act in the Owner’s behalf in all issues.
Q. Owner Project Requirements (OPR): Documentation of the functional requirements of the facility and the expectations of how it will be used and operated. This includes Project and design goals, measurable performance criteria, budgets and schedules and supporting information.

R. Performance Metrics/Benchmark: Measurable indicators that allow verification that a specific Owner Objective or Requirement or element in the Design Narrative has been met. Performance Metrics are identified throughout the design of the Project with as many as possible being generated during the development of the Owner Objectives.

S. Phased Commissioning: Commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling issues, in order to minimize the total construction time.

T. Sampling: Functionally testing only a fraction of the total number of identical or near identical pieces of equipment.

U. Seasonal Tests: Tests that are deferred until the system(s) will experience conditions closer to their design conditions.

V. Simulated Condition: Condition that is created for the purpose of testing the response of a system.

W. Simulated Signal: Disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.

X. Start-up: The initial starting or activating of dynamic equipment, including executing construction checklists.

Y. Systems Manual: A manual giving the operating staff the information needed to understand and optimally operate each system. The manual is in addition to the O&M Manuals submitted by the Contractor.

Z. Test: Assessments that verify specific components, assemblies, systems, and interfaces among systems function and perform in accordance with the Owner’s objectives and the Contract Documents. Testing may include using manual (direct observation) or monitoring methods. Testing is the dynamic testing of specific and interacting equipment and systems in full operation. Tests are generally performed after construction checklists and start-up are complete. Some procedures in construction checklists test components, but reference to “testing” generally refers to those equipment and system tests conducted after Contractor startup and initial checkout.

AA. Trending: Monitoring using the building control system.

1.4 RESPONSIBILITIES

A. Overview: The responsibilities of the parties in the commissioning process are summarized in the following responsibility matrix. For detailed information on the roles of the Trade Subcontractors refer to Specification 22 08 00 Commissioning of Plumbing Systems, 23 08 00 Commissioning of HVAC Systems and 26 08 00 Commissioning of Electrical Systems.

**Responsibility Matrix**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Task / Action</th>
<th>CxA</th>
<th>Owner</th>
<th>A/E Design Team</th>
<th>CG/CM Team</th>
<th>Trade Contractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>OPR</td>
<td>Review</td>
<td>Prepare</td>
<td>Review</td>
<td>Review</td>
<td>-</td>
</tr>
<tr>
<td>Design</td>
<td>BOD</td>
<td>Review</td>
<td>Review</td>
<td>Prepare</td>
<td>Review</td>
<td>-</td>
</tr>
<tr>
<td>Design</td>
<td>Cx Specs</td>
<td>Prepare</td>
<td>Review</td>
<td>Incorporate in CDs</td>
<td>Review</td>
<td>-</td>
</tr>
<tr>
<td>Design</td>
<td>Cx Plan</td>
<td>Write</td>
<td>Review &amp; Comment</td>
<td>Review &amp; Comment</td>
<td>Review, Comment</td>
<td>-</td>
</tr>
<tr>
<td>Design</td>
<td>Review construction documents</td>
<td>Review of Docs for FPT preparation</td>
<td>Review</td>
<td>Provide docs &amp; Respond to questions</td>
<td>Review</td>
<td>-</td>
</tr>
<tr>
<td>Construction</td>
<td>Cx Kickoff Meeting</td>
<td>Lead</td>
<td>Attend</td>
<td>Attend</td>
<td>Attend</td>
<td>Attend</td>
</tr>
<tr>
<td>Construction</td>
<td>Write Pre-Functional Checklists</td>
<td>Write</td>
<td>Review and comment</td>
<td>Review &amp; Comment</td>
<td>Review, Comment, &amp; Buy-in</td>
<td>Review, Comment, &amp; Buy-in</td>
</tr>
<tr>
<td>Construction</td>
<td>Write Functional Performance Tests procedures</td>
<td>Write</td>
<td>Review &amp; Comment</td>
<td>Review &amp; Comment</td>
<td>Review, Comment, &amp; Buy-in</td>
<td>Review, Comment, &amp; Buy-in</td>
</tr>
<tr>
<td>Construction</td>
<td>Cx Meetings during Construction phase</td>
<td>Lead</td>
<td>Attend</td>
<td>Attend</td>
<td>Attend</td>
<td>Attend</td>
</tr>
<tr>
<td>Construction</td>
<td>CxA visit site to review progress</td>
<td>Observe</td>
<td>Review Field Reports</td>
<td>Review Field Reports</td>
<td>Coordinate and Attend</td>
<td>Attend</td>
</tr>
<tr>
<td>Construction</td>
<td>Deficiency Log</td>
<td>Write</td>
<td>Review</td>
<td>Review</td>
<td>Correct, &amp; Verify completion</td>
<td>Correct, &amp; Verify completion</td>
</tr>
</tbody>
</table>

[Table continues with more rows for each phase listed above, including additional responsibilities and tasks associated with each phase.]
<table>
<thead>
<tr>
<th>Construction</th>
<th>Review Submittals of Systems Being Commissioned</th>
<th>Review</th>
<th>Review</th>
<th>Review</th>
<th>Provide Submittals</th>
<th>Provide Submittals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Equipment start-up and checkout</td>
<td>Review</td>
<td>Review</td>
<td>Review</td>
<td>Perform, &amp; Verify Completion</td>
<td>Perform, &amp; Verify Completion</td>
</tr>
<tr>
<td>Acceptance</td>
<td>Test and Balance</td>
<td>Verify</td>
<td>Review</td>
<td>Review</td>
<td>Perform, &amp; Verify Completion</td>
<td>Perform, &amp; Verify Completion</td>
</tr>
<tr>
<td>Acceptance</td>
<td>Perform Functional Performance Tests</td>
<td>Observe, Document</td>
<td>Observe</td>
<td>Participate</td>
<td>Schedule and Execute</td>
<td>Schedule and Execute</td>
</tr>
<tr>
<td>Acceptance</td>
<td>Deficiency Log</td>
<td>Write</td>
<td>Review</td>
<td>Review</td>
<td>Correct, &amp; Verify Completion</td>
<td>Correct, &amp; Verify Completion</td>
</tr>
<tr>
<td>Acceptance</td>
<td>Preliminary Cx Report</td>
<td>Write</td>
<td>Review &amp; Comment</td>
<td>Review</td>
<td>Review</td>
<td>NA</td>
</tr>
<tr>
<td>Acceptance</td>
<td>O&amp;M Manual</td>
<td>Review</td>
<td>Review and Accept</td>
<td>NA</td>
<td>Compile</td>
<td>Provide O&amp;M documents</td>
</tr>
<tr>
<td>Occupancy &amp; Operation</td>
<td>Final Cx Report</td>
<td>Write</td>
<td>Review &amp; Comment</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

B. In general the CxA writes the tests and documents the test results. The Contractor is responsible to execute the tests.

1.5 SUBMITTALS

O&M MANUALS: The Contractor shall prepare O&M manuals, including clarifying and updating the original sequences of operation to as-built conditions, and submit to the owner within 90 days of the date of receipt of the certificate of occupancy.

1) CxA Review: Prior to Substantial Completion, the CxA will review the Operation and Maintenance (O&M) manuals, documentation, “redline” as-builts, and warranty information for all commissioned systems. Deficiencies will be communicated to Owner and the A/E for consolidation with other review comments and resolution/correction by the Contractor.

2) Single Line System Diagrams. The Contractor shall provide simplified professionally drawn, computer generated single line system diagrams on 8 ½” x 11” or 11” x 17” sheets.

3) These shall show major pieces of equipment such as pumps, heat exchangers, air handling equipment, coils, control valves, expansion tanks, coils, service valves, etc. In some cases, the single line control diagrams submitted by the Contractor can suffice if updated to as-built status and approved by the Owner and CxA for this purpose.

Draft TAB Report: The Contractor shall submit the draft Testing and Balancing (TAB) Report, describing the activities and measurements completed, to the CxA for review and to the Mechanical Engineer of Record for approval. This draft report must be submitted two weeks prior to the beginning of Functional Performance Testing to allow time for review and approval. Functional Performance Testing will not be scheduled until the Engineer has approved the report.

Final TAB Report: The Contractor shall submit the final System Testing and Balancing (TAB) Report, describing the activities and measurements completed, to the Owner within 90 days of the date of receipt of the certificate of occupancy.

Record Drawings: Final record drawings shall be prepared by the Contractor, and submitted to the owner within 90 days of the date of receipt of the certificate of occupancy.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

The Contractor shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, and FPT of systems and equipment. Test equipment shall be of sufficient quality and accuracy to test and/or measure system performance according to specified tolerances.

1) Test instruments shall bear a valid NIST-traceable calibration stamp.

2) Frequency of calibration shall be in accordance applicable NEBB, AABC, or IEEE requirements. All standard testing equipment required for the Contractor to perform installation, start-up and initial checkout and required testing shall be provided by the Contractor.
Special tools and instruments, only available from vendor, specific to a piece of equipment, required for testing equipment according to these Contract Documents shall be included in the base bid price.

2.2 TEST EQUIPMENT CALIBRATION:

- The Contractor shall submit, within 90 days of notice to proceed and 30 days before any testing is performed, documentation of meeting the following calibration requirements.
- Electrical equipment testing instruments must be calibrated in accordance with the following frequency:
  - Field Instruments: Analog, 6 months maximum, digital, 12 months maximum.
  - Laboratory Instruments: 12 months.
  - Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.
- All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications.
- If not otherwise given, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 degrees F and a resolution of + or - 0.1 degrees F.
- Pressure sensors shall have an accuracy of + or - 2.0 percent of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer’s recommended intervals. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 COORDINATION

Scheduling: The Contractor shall provide sufficient notice to the Commissioning Authority regarding the installation of static assemblies being commissioned and the schedule for the construction checklists, start-up and initial checkout of all commissioned dynamic equipment and systems.

Meetings: The Contractor will coordinate with the Commissioning Authority in a number of areas as described in this Section in order to facilitate the successful completion of the commissioning plan.

The Commissioning Authority will plan, conduct and take minutes at commissioning meetings.

All commissioning meetings shall be attended by the Contractor, and all appropriate or requested sub-contractors.

The number of specific meetings dedicated to commissioning is provided in the Commissioning Plan. If the number of deficiencies is abnormal or coordination or cooperation is insufficient, additional meetings or meeting durations shall be required.

Controls Integration Meetings: The Commissioning Authority coordinates a series of meetings to go over the control drawings, sequences of operation, points list and database and controls submittal requirements. These meetings are held prior to a formal control drawing submittal and any programming. The intent is to clarify control related issues for the Contractor, and appropriate sub-Contractor, Owner facility staff and Commissioning Authority prior to final point database development, programming and the formal control drawing submittal.

3.2 PRE-FUNCTIONAL CHECKLISTS, START-UP, AND INITIAL CHECKOUT

The following procedures shall apply to all equipment and systems to be commissioned.

Pre-Functional Checklists:

- The Commissioning Authority develops new or adapts existing representative Pre-Functional checklists and procedures for commissioned equipment and assemblies.
- The Contractor is responsible to calibrate all field-installed sensors and actuators using test and documentation methods approved by the Commissioning Authority.
- On each Checklist the Contractor shall identify which trade or contractor is responsible for executing and documenting each of the line item tasks and shall note that trade on the checklist form.
- Checklists may be attached to start-up procedure forms.

Manufacturer Installation and Startup Procedures:

- The Contractor shall document their installation and startup utilizing manufacturer installation and startup procedures, check sheets and reports, in addition to the commissioning checklists.
- The completed manufacturer startup reports shall be submitted to the Commissioning Authority within 5 days of startup. The Contractor shall clearly note any items that have not been completed and the plan for their completion.

Execution of Pre-Functional Checklists and Start-up:

- Each piece of equipment shall receive full construction checkout by the Contractor following the approved plan and forms. No sampling strategies are used. Only individuals that have direct knowledge and witnessed that a line item task on the construction checklist was actually performed shall initial or check that item off. It is not acceptable for non-witnessing supervisors to fill out the forms.
(8) The Contractors shall complete the pre-start procedures in the checklist prior to starting equipment, including but not limited to verification of completion of wiring, safeties, lubrication, drive rotation and proper electrical test readings. Startup shall be conducted under supervision of responsible manufacturer representatives for major pieces of equipment. The Contractor shall notify the Commissioning Authority at least 5 days in advance of any equipment start-up, providing the Commissioning Authority a copy of the pre-start sections of the installation and start-up plan at that time.

(9) The Commissioning Authority may observe installation, start-up and checkout of selected systems. Procedures on the plans and checklists will be spot-checked by the Commissioning Authority prior to testing.

(10) The Contractor shall execute start-up and provide the Commissioning Authority with a signed and dated copy of the completed construction checklists and installation and start-up documentation. The Contractor shall clearly note any items that have not been completed and the plan for their completion.

(11) The Contractor shall operate each commissioned device or assembly to the full extent of its capability, from minimum to maximum, under automatic and manual control and verify that the equipment, system and assembly is functioning according to the specifications, manufacturer's recommendations and good operating practice.

(12) The Construction Checklist and manufacturer installation and startup check sheets and procedures for a given system shall be successfully completed and submitted prior to formal testing or testing, adjusting and balancing of the equipment.

(13) Where final balancing of a system or particular components are not specifically indicated to be performed by the Owner or Owner's consultants, the Contractor and Contractor shall provide final balancing and adjustments for operation within specified tolerances prior to testing and demonstration of such system.

(14) The Contractor shall submit installation, startup and checkout documentation prior to testing equipment.

(15) The Commissioning Authority will review installation, startup and checkout documentation and identify incomplete areas.

(16) The Contractor shall correct all areas that are deficient or incomplete in the checklists in a timely manner.

3.3 FUNCTIONAL TESTING

The Contractor shall be responsible to fully test all systems and assemblies according to the Specifications. The Commissioning Authority will direct, witness and document most of the mechanical systems tests.

The following matrix indicates the systems to be tested:

<table>
<thead>
<tr>
<th>Systems and Major Equipment</th>
<th>Included in Cx Scope of Work?</th>
<th>Quantity to be Commissioned</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mechanical Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major New HVAC Equipment: Rooftop Package Units, Dedicated Outdoor Air Units (DOAS)</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>New DX Split Systems</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>New Exhaust Fans</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>Existing Rooftop Package Units</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>HVAC Controls</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Service Water Heating Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Water Heaters</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>Recirculation Pumps</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>Mixing Valves</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>Controls</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Electrical Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting / Daylighting Controls</td>
<td>Yes</td>
<td>100%</td>
</tr>
</tbody>
</table>

The Contractor shall execute all tests, except at the discretion of the Commissioning Authority and approval of the Contractor, the Commissioning Authority may execute tests of selected equipment.
Tests for a given system or assembly shall not be conducted until they are fully operational under normal and reliable control with control calibrations, programming and control system graphics complete and checked out and the Contractor have submitted a completed construction checklist and where applicable a startup report, satisfactory to the Commissioning Authority.

Objectives and Scope:

(1) The objective of testing is to demonstrate that each system is operating according to the documented Owner Objectives and Contract Documents. For dynamic systems, testing facilitates bringing the systems from a state of initial operation to full dynamic operation. For static elements, testing verifies the performance of the assembly in its installed state under conditions specified in the testing requirements. Additionally, during the testing process, areas of deficient performance are identified and corrected.

(2) In general, testing shall include each item in the sequence of operations, and other significant modes, sequences and control strategies not mentioned in the written sequences; including, but not limited to startup, shutdown, unoccupied and manual modes, modulation up and down the unit’s range of capacity, power failure, alarms, component staging and backup upon failure, interlocks with other equipment, and sensor and actuator calibrations.

(3) All interlocks and interactions between systems shall be tested.

(4) All larger equipment will be individually tested. Like units or assemblies that are numerous may have an appropriate sampling strategy applied. Refer to the Commissioning Plan for sampling requirements. Heating equipment should be tested appropriately during winter and air conditioning equipment should be tested appropriately during summer to demonstrate performance under near-design conditions.

Setup: Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor shall provide all necessary materials, system modifications, etc., to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

Testing Order: In general, testing is conducted after Pre-Functional Checklists and start-up has been satisfactorily completed. The control system is sufficiently tested and approved by the Commissioning Authority before it is used for testing, adjusting and balancing or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before testing of air-related or water-related equipment or systems. Testing generally proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is verified.

Problem Solving: The burden of problem solving is on the Contractor and the Designers, though the Commissioning Authority may recommend solutions to problems found.

Sampling: The following is a summary of the systems that are intended to be Functional Performance Tested as part of this project.

(5) The Contractor is responsible for testing 100% of all systems and components as part of their normal scope of work unless sampling is permitted by the Commissioning Plan. The table in Paragraph 3.3.B offers a descriptive listing of equipment and components which will be tested and witnessed by the CxA for each of the typical systems during the commissioning process. Sampling may be permitted – review the Commissioning plan for sampling allowances and minimum quantities.

(6) If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the Commissioning Authority may stop the testing and require the Contractor to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units. Deficiency correction time and follow-up tests shall be required when deficiencies are discovered.

The costs for extensive retesting or expanded sample Functional Performance Tests shall be solely the responsibility of the Contractor. Any required retesting or expanded sample testing by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

3.4 ISSUES AND NON-CONFORMANCE

The Commissioning Authority will record the results of document reviews, field observations, tests conducted or reviewed and trend logs or monitoring. All deficiencies or non-conformance issues will be recorded on a master Issues Log kept by the Commissioning Authority. The Issues Log will be kept updated by the Commissioning Authority.

A current copy of the Issues Log will be provided to the Contractor and Owner on a regular basis, as requested by the Contractor or Owner. New issues since the last printing will be clearly identified.

Issues warranting a request for information (RFI) will be forwarded by the Commissioning Authority to the designated party for developing the RFI, or the Commissioning Authority will generate and forward the RFI directly.
Issues of non-compliance or items that are incomplete or are requiring Designer input will be sent to the Contractor or Designer and Owner by the Commissioning Authority via appropriate channels. The Commissioning Authority documents resolutions in the Issues Log and schedules retesting and re-inspection as needed.

Corrections of minor issues identified may be made during the tests at the discretion of the Commissioning Authority and with the issue and resolution documented in the Issues Log. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Commissioning Authority will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the written request of the Owner.

Cost of Retesting: The Contractor shall reimburse the Owner and Commissioning Authority for costs when a scheduled test cannot be completed due to, but not limited to the following:

1. Failure of the Contractor to schedule the test with all parties required to perform the test or with regulatory authorities required to witness the test.
2. Failure of the Contractor to provide required notice for tests that have been cancelled or rescheduled.
3. Failure of the Contractor to have in place test equipment, support equipment, instrumentation, permits, or other ancillary equipment or systems required for successful execution of the test.
4. Failure of the Contractor to complete pre-start or start-up procedures or other work required as a prerequisite for execution of the test.

Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or time extension by the Contractor.

3.5 APPROVAL AND ACCEPTANCE:

The Commissioning Authority will note each satisfactorily demonstrated function on the test form. However, formal approval of an entire test form is not normally given. Functional approval or acceptance of a system is indicated after all testing and monitoring is complete and there are no outstanding issues for that equipment or assembly in the Commissioning Authority’s Issues Log.

3.6 DEFERRED TESTING

Unforeseen Deferred Tests: If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and testing may be delayed upon written approval of the Owner.

Seasonal Testing: During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system’s design) specified in the testing requirements shall be completed as part of this contract. The Commissioning Authority will coordinate this activity. Tests will be executed, documented and deficiencies corrected by the Contractor, with facilities staff and the Commissioning Authority witnessing. The Contractor shall make needed final adjustments to the O&M manuals and Record Documents due to the testing results.

3.7 SCHEDULE

The Owner and Contractor shall work with the Commissioning Authority using established protocols to schedule the commissioning activities. The Owner and Contractor shall integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process. As construction progresses, more detailed commissioning schedules shall be developed.

The Contractor shall provide a minimum of 2 weeks’ notice prior to the date of testing to the Owner and Commissioning Authority. In addition, the Commissioning Authority and Owner shall be notified 48 hours in advance when tests are canceled or rescheduled.
SECTION 024113

SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes the following:
   1. Demolition and removal of selected site elements and building remnants.
   2. Demolition and removal of existing paving, curbs, sidewalks, and adjacent landscape work to limits indicated on Drawings.
B. Items of interest or value to Owner that may be encountered during selective demolition shall remain Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.

1.2 REFERENCES
A. American National Standard Institute (ANSI):
   1. ANSI A 10.6 “Demolition, Safety Requirements”
B. National Fire Protection Association (NFPA)

1.3 DEFINITIONS
A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 INFORMATIONAL SUBMITTALS
A. General: Submit the following under provisions of Section 013300.
B. Schedule of Selective Demolition Activities: Indicate the following:
   1. Interruption of utility services. Indicate how long utility services will be interrupted.
   2. Coordination for shut-off, capping, and continuation of utility services as required.
   3. Owner’s On-Site Operations: Provide a detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner’s off-site operations.
   4. Means of protection for items to remain and items in path of waste removal from site.
C. Qualification Data: Qualification data for firms and persons specified in “Quality Assurance” article to demonstrate their capabilities and experience. Include list of completed projects with project name, addresses, names of Architects and Owners, and other information specified.
D. Pre-demolition Photographs or Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations. Comply with Division 01 Section “Photographic Documentation.” Submit before Work begins.
E. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
F. Closeout Submittals: Record documents, indicating locations of encountered items, whether currently in use or abandoned in place.

1.5 QUALITY ASSURANCE
A. Qualifications:
   1. Contractor: Contractor is responsible for quality control of the Work.
   2. Demolition Firm: A firm experienced in successfully demolition and removal of work similar to that indicated for this Project, with a record of successful performance, and with sufficient capacity to provide demolition, removal, and legal disposal of debris without causing delay in the Work.
B. Regulatory Requirements: Comply with all applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.
1. Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
2. Comply with ANSI A 10.6 and NFPA 241.

C. Pre-demolition Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to selective demolition.

1.6 PROJECT CONDITIONS OR SITE CONDITIONS

A. Environmental Requirements: Proceed with the Work in accordance with governmental requirements.

B. Condition of Site Elements: Owner assumes no responsibility for actual condition of site elements to be demolished.
1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner insofar as practicable. However, variations may occur by Owner's removal and salvage operations prior to start of demolition work.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Recycled Materials: Items of recycled value to Contractor may be removed from structure as work progresses. Recycled items shall be transported from site as they are removed. Comply with governing regulations pertaining to environmental protection.

E. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
1. Hazardous Materials: If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

F. Explosives: Use of explosives will not be permitted.

G. Traffic: Conduct demolition operations and removal of debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

H. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

I. Protections: Ensure safe passage of persons around areas of demolition. Conduct operations to prevent injury to adjacent buildings, structures, other facilities, and persons.
1. Erect temporary covered passageways as required by authorities having jurisdiction.
2. Provide shoring, bracing, or support to prevent movement, settlement or collapse of structures to be demolished and adjacent facilities to remain.

J. Damages: Promptly repair damages caused to adjacent facilities by demolition operations at no cost to Owner.

K. Utility Services: Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.
1. Do not interrupt existing utilities serving adjacent facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.

L. Utility Services: Refer to applicable Sections for disconnecting, removal, and capping of utility services. Do not start demolition work until utility disconnections have been completed and verified in writing.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs and preconstruction videotapes.
1. Comply with requirements specified in Division 01 Section "Photographic Documentation."
3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.
   1. Comply with requirements for existing services/systems interruptions specified in Division 01 Section "Summary of Work."

B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
   2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
   3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of existing adjacent buildings.

C. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
   1. Strengthen or add new supports when required during progress of demolition.

D. Pollution Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.
   1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

3.4 DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Proceed with demolition in systematic manner, from top of structure to ground. Complete demolition work above each floor or tier before disturbing supporting members on lower levels.
   2. Demolish concrete and masonry in small sections.
   3. Break up and remove concrete slabs-on-grade, unless otherwise shown to remain.

B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

C. Below-Grade Construction:
   1. Demolish and remove below-grade construction and concrete slabs on grade.
   2. Use satisfactory soil materials consisting of stone, gravel, and sand, free from debris, trash, frozen materials, roots and other organic matter.
   3. Prior to placement of fill materials, ensure that areas to be filled are free of standing water, frost, frozen material, trash and debris.
   4. Place fill materials in horizontal layers not exceeding 6" in loose depth. Compact each layer at optimum moisture content of fill material to a density equal to original adjacent ground, unless subsequent excavation for new work is required.
   5. After fill placement and compaction, grade surface to meet adjacent contours and to provide flow to surface drainage structures.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. At the end of each workday, remove unused materials, debris and containers from the site.
C. Burning of removed materials from demolished structures will not be permitted on site.
D. Disposal: Transport demolished materials off Owner's property and legally dispose of them.
E. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024113
SECTION 024116
BUILDING DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Demolition of designated structures and removal of materials from site.
   2. Demolition and removal of foundations and slabs-on-grade.
   3. Disconnection and removal of identified utilities.
   4. Removal of underground tanks and piping.

1.2 SUBMITTALS
A. General: Submit in accordance with Section 013300.
B. Shop Drawings: Indicate demolition and removal sequence and location of salvable items; location and construction of barricades, fences, and temporary work.
C. Demolition Schedule: Submit schedule showing time and detailed sequence of demolition, removal of materials, arranged shut-off and removal or capping of utility services.
D. Informational Submittals: Submit Qualification data packaged separately from other submittals: Demolition contractor's qualification data.
E. Closeout Submittals: Project Record Documents: Submit in accordance with Section 017839. Accurately record actual locations of capped utilities and subsurface obstructions.

1.3 QUALITY ASSURANCE
A. Contractor Qualifications: Company specializing in demolition work with minimum of three years documented experience.
B. Regulatory Requirements: Comply with:
   1. Applicable codes, ordinances, rules, regulations, and laws of local, municipal, state and federal authorities having jurisdiction.
   2. Obtain and pay for necessary permits and notices; post where required.
   3. Safety requirements of local fire department.
   4. ANSI A10.6.
C. Notify affected utility companies before starting Work and comply with their requirements.
D. Do not close or obstruct roadways, sidewalks, and hydrants without permits.
E. Test soils around buried tanks for contamination. Proceed under written instructions from Owner.

1.4 PRE-DEMOLITION CONFERENCE
A. Conduct conference in accordance with Section 013100 to discuss following:
   1. Present draft of demolition schedule for review.
   2. Coordinate phasing requirements.
   3. Identify items to be protected and preserved before proceeding with Work.
   4. Conduct walking inspection to identify materials and equipment to be salvaged for re-installation and Owner use.
   5. Agree upon location where items salvaged for Owner are to be delivered and stored.

1.5 PROJECT CONDITIONS
A. Occupancy: Owner will vacate building prior to start of demolition work.
B. Condition of Structures:
   1. Owner assumes no responsibility for actual condition of structures to be demolished.
   2. Variations within structure may occur because of Owner's salvage operations.
   3. Copies of existing building drawings are available for review upon request; contact Owner's representative.
C. Hazardous Materials: Inform Owner immediately upon discovery of asbestos products, radioactive materials, radon gas, toxic wastes, or other similar hazardous materials.
   1. Strictly follow regulations applicable to hazardous materials.
   2. Do not remove hazardous materials without Owner authorization.
D. Explosives: Not permitted.
E. Traffic and Passageways: Maintain accessibility for firefighting apparatus.
1. Conduct demolition operations and debris removal to avoid interference with use of roads, streets, walks, and adjacent occupied facilities.
2. Obtain written permission from authorities having jurisdiction prior to closing or obstructing streets, walks, or other adjacent occupied facilities.
3. Provide alternate routes when closing or obstructing traffic ways when required by governing authorities.

F. Protection: Perform Work in manner to eliminate hazards to persons or property and avoid interference with adjacent areas, utilities and structures.
1. Provide and maintain temporary barricades, fences, guardrails, warning signs, warning lights, and other similar provisions as necessary for protection of persons.
2. Provide and maintain fire extinguishers; comply with requirements of governing authorities.
3. Maintain existing utilities which are to remain in service and protect from damage during demolition operations.

1.6 SEQUENCING
A. Sequence activities to demolish the Work in following order:
1. Prior to new construction in accordance with phased construction plan/schedule developed by GC/CMAR.
B. Schedule work in accordance with Section 013200.
C. Describe demolition removal procedures and schedule.
D. Perform work between hours of 7 AM and 5 PM.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Fill Material: Refer to Division 31 “Earthwork” for select fill material.
B. Excavated material tested and approved in accordance with Section 014000 and Division 31 “Earthwork” may be used as fill material.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine conditions and proceed with work in accordance with Section 017300.
1. Verify structure is unoccupied.

3.2 PREPARATION
A. Provide, erect, and maintain temporary barriers and security devices in accordance with approved submittals.
B. Protect existing improvements including structures, landscaping materials, appurtenances which are not to be demolished.
1. Prevent movement or settlement of adjacent structures. Provide bracing and shoring as necessary.
2. Review existing documents to determine presence and precise locations of any underground structures, tanks, etc, that will be required to be demolished. Refer to demolition requirements stated later in this Section.
C. Disconnect Utilities: Mark and identify location of utilities to be disconnected.
1. Notify affected utility companies in advance of date and time when service needs to be disconnected.
2. Disconnect and Cap Utilities: Where indicated on Drawings, disconnect and cap utility services; comply with requirements of governing authorities.
3. Disconnect and Remove Utilities: Where indicated on Drawings, disconnect and remove utility services; comply with requirements of governing authorities.
   a. Remove culverts, storm sewers, manholes and inlets in proper sequence for maintenance of traffic and drainage.
   b. Backfill and tamp holes remaining after removal of obstructions.
   c. Complete operation by blading, grading or bulldozing so that prepared area is free of holes, ditches, abrupt changes in elevations, and irregularities of contour and drainage of area are preserved.
3. Plug remaining ends of abandoned storm sewers, culverts, sanitary sewers, conduits and water or gas pipes over 3 inch diameter with concrete to form tight closure when backfilling is required.
4. Do not commence demolition operations until associated disconnections have been completed.
D. Exterminate vermin and rodents in structures to be demolished. Utilize licensed exterminator operating in compliance with applicable governing regulations.
3.3 SALVAGEABLE MATERIAL AND EQUIPMENT

A. Remove, Protect and Store for Owner: Carefully remove, store and protect following salvage materials and equipment for Owner’s use. Deliver to location directed by Owner.
   1. TBD.

B. Remove, Protect and Store for Owner: Carefully remove, store and protect materials and equipment indicated to be salvaged for Owner’s use. Deliver to location directed by Owner.

C. Materials Retained by Contractor: Items of salvable value not indicated as Owner salvaged or scheduled for reinstallation may be removed as work progresses.
   1. Remove salvaged items from site as they are removed from structure. Storage or sale of salvaged items on site not allowed.

3.4 DEMOLITION

A. General: Conduct demolition to minimize interference with adjacent structures.
   1. Cease demolition operations immediately if adjacent structures appear to be in danger. Conduct safety operations as necessary. Do not resume demolition operations until directed.
   2. Conduct operations with minimum interference to public or private accesses. Maintain egress, access at all times.
   3. Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon or limit access to their property.
   4. Sprinkle debris with water to minimize dust. Provide hoses and water connections as necessary.
   5. Do not cause flooding or contaminated runoff.

B. Demolish indicated structures and appurtenances in orderly manner. Remove demolished materials from site daily.
   1. Perform demolition in accordance with governing authorities.
   2. Remove and immediately dispose of contaminated or vermin infested materials when encountered.
   3. Do not burn or bury materials or debris on site. Leave site in clean condition.

C. Underground Tanks: Empty underground tanks located within demolition area; remove tanks, piping and associated components. Comply with all applicable requirements, ordinances, regulations and laws of EPA and the authority having jurisdiction. Where conflicts in requirements arise, comply with the more stringent requirements.

D. Foundations: Remove foundation walls and associated footings minimum of 24 inches below finished grade.
   1. Remove basement walls minimum of 24 inches below finish grade and break-up basement concrete floor slabs in 3 feet maximum dimensions to permit removal.
   2. Remove concrete slabs on grade.

E. Backfilling: Utilize laboratory approved demolished inorganic material to fill basement pit to within 24 inches of finish grade.

F. Backfilling: Backfill open pits and holes caused as result of demolition. Use fill materials specified in Division 31 Section “Earthwork”.
   1. Do not backfill until areas to be filled are free of standing water, frost, frozen material, trash and debris.
   2. Place fill in horizontal layers not exceeding 9 inches in loose depth. Compact each layer at optimum moisture content of fill materials to a density equal to original adjacent ground, unless subsequent excavation for new work is required.

3.5 ADJUSTING AND CLEANING

A. Adjusting: After fill placement and compaction, grade surface to meet adjacent contours with uniform slope to surface drain.

B. Cleaning: Comply with Section 017700 “Closeout”. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing prior to start of Work.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Grade Beams and pier caps
2. Slabs-on-Void Boxes.
3. Drilled Piers

B. WORK INCLUDED

1. Design, fabrication, erection, and stripping of formwork for cast-in-place concrete including shoring, reshoring, falsework, bracing, proprietary forming systems, prefabricated forms, void forms, permanent metal forms, bulkheads, keys, blockouts, sleeves, pockets, and accessories. Erection shall include installation in formwork of items furnished by other trades.

2. Furnish all labor and materials required to fabricate, deliver and install reinforcement and embedded metal assemblies for cast-in-place concrete, including steel bars, welded steel wire fabric, ties and supports.

3. Furnish all labor and materials required to perform the following:
   a. Cast-in-place concrete
   b. Concrete mix designs
   c. Grouting structural steel baseplates
   d. Concrete for drilled piers

C. Related Sections include the following:

1. Division 31 Section “Drilled Piers” for drilled concrete piers.
2. Division 32 Section “Concrete Paving” for concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, Slag Cement, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

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

B. Design Mixtures: For each concrete mixture, submit proposed mix designs in accordance with ACI 318 requirements. Each proposed mix design shall be accompanied by a record of past performance.

1. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

2. Indicate amounts of mixing water to be withheld for later addition at Project site.
C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1. Do not reproduce the structural drawings for use as shop drawings.
2. Embedded metal assemblies: Submit shop drawings for fabrication and placement. Use standard AWS welding symbols.

D. Steel Reinforcement Submittals for Information: Mill test certificates of supplied concrete reinforcing, indicating physical and chemical analysis.

E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates.

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

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

G. Submit manufacturer's certification of maximum chloride ion content in admixtures.

H. Fly ash: Submit certification attesting to carbon content and compliance with ASTM C618.

I. Construction Joint Layout: Submit a diagram of proposed construction joint locations for horizontal framing that exceed the limits of a single placement as stated in the structural notes, other than those indicated on the Drawings.

J. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.

K. Field quality-control test and inspection reports.

L. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. 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.

B. 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."

C. Testing Agency Qualifications: An independent agency, 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-01 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.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete,"
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: Owner may engage a qualified independent testing agency to perform material evaluation tests.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

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.

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, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Store all proprietary materials in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

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

1. ACI 301 (ACI 301M).
2. ACI 117 (ACI 117M).
2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
   a. High-density overlay, Class 1 or better.
3. Steel Forms

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Void Forms: Shall be the product of a reputable manufacturer regularly engaged in the commercial production of void forms.

1. Void form composition shall be of corrugated paper material with a moisture resistant exterior and an interior fabrication of a uniform cellular configuration, composed of components constructed of double-faced wax-impregnated (partially or fully), corrugated fiberboard that is laminated with moisture resistant adhesive.
2. Design and maintain void forms to support all vertical and lateral loads that might be applied during construction until such loads can be supported by the concrete structure.
3. Form material shall be designed to lose its strength under prolonged contact with the moisture which normally accumulates beneath slabs and beams on grade.
4. Void forms shall be used around the circular edges of all drilled piers at the intersection of the grade beams and/or structural slabs by using premanufactured, non-field cut, sealed void forms with curved edges adjacent to drilled piers.
5. Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, VoidForm Products, Inc., Englewood, Colorado.

D. Protection Board: For use over void forms under structural slabs. Hard-pressed cellulose fiber board, 1/8 inch minimum thickness.


F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.


H. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

I. Soil Retainers: Shall be provided where specified and shown on the drawings to prevent migration of backfill under suspended foundation elements:

1. Retainers shall be composed of high density polypropylene materials that are not adversely affected by moisture. They must be flexible, impact resistant and have sufficient strength to resist lateral loads applied by soil.
a. Thickness: 1/2” for void spaces greater than 8”, but less than 12”, inclusive.
b. Soil retainers shall extend six inches above the void forms and a minimum of 3 inches below the void forms.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Deformed-Bar Anchor: ASTM A1064/ A1064M.

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

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For slabs on grade and slabs on void forms, provide sand plates, horizontal runners, or precast concrete blocks on bottom where base material will not support chair legs or where vapor barrier has been specified.

2.5 MECHANICAL SPLICES

A. Provide mechanical splices designed to develop, in tension and compression, 125 percent of the minimum ASTM specified yield strength of the smaller bar being spliced. The following splicing systems are acceptable:

1. Erico "Cadweld T-Series"
2. Erico "Lenton"
3. Dayton Barsplice "Bar-Grip"
4. Dayton Barsplice "Grip-Twist"

2.6 EMBEDDED METAL ASSEMBLIES

A. Steel Shapes and Plates: ASTM A36

B. Headed Studs: Heads welded by full-fusion process, as furnished by TRW Nelson Stud Welding Division.

C. Reinforcing Bars to be Welded: ASTM A706.

D. Coatings

1. Epoxy coating for metal assemblies shall be "Hi-Build Epoxoline," as manufactured by the Tnemec Company, Kansas City, Missouri, applied in accordance with manufacturer's recommendations.
2.7 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement: ASTM C 150, Type I/II, gray. Supplement with the following:
      a. Fly Ash: ASTM C 618, Class F or C.
      b. Slag Cement: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.
   1. Maximum Coarse-Aggregate Size: As indicated on drawings.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.


2.8 ADMIXTURES


B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.9 WATERSTOPS

A. VAPOR RETARDERS

B. Plastic Vapor Retarder: ASTM E 1745, Class A.
   1. Membrane shall have the following properties:
      a. Minimum 15 mils thickness.
      b. Permeance Rating: ASTM E96, 0.01 Perms [grains/(ft² * hr *- in Hg)] or lower as tested after mandatory conditioning (ASTM E 154 sections 8, 11, 12, 13)
      c. Installation shall be in accordance with ASTM E1643 and manufacturer’s instructions.
   2. Products:
      a. Carlisle Coatings & Waterproofing, Inc.: Blackline 400.
      b. Epro; Ecoshield-E 15 mil.
      c. Inteplast Group: Barrier Bac VBC-350 Composite Vapor Retarder
      d. Reef Industries; Vaporguard.
      e. Stego Wrap 15 mil, by Stego.
   3. Accessories
a. Perimeter/seam sealing tape for use with membranes that are not self-adhering to the underside of concrete slabs on void forms:
   1) Crete Claw detail tape by Stego Industries, LLC, for adhering vapor retarder membrane to the underside of concrete surface at slabs on carton void forms, 3-inch and 6-inch widths as noted in Part 3.
   2) StegoTack double-sided adhesive tape by Stego Industries, LLC, for adhering membrane to concrete at gradebeams.

b. Manufacturer’s recommended standard adhesive or pressure sensitive tape for general use.

2.10 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

   1. Products:
      a. Axim Concrete Technologies; CATEXOL Cimfilm.
      b. BASF Construction Chemicals – Building Systems; Confilm.
      c. ChemMasters; Spray-Film.
      d. Conspec by Dayton Superior; Aqufilm.
      e. Dayton Superior Corporation; Sure Film (J-74).
      f. Edoco by Dayton Superior; BurkeFilm.
      g. Euclid Chemical Company (The), an RPM company; Eucobar.
      h. Kaufman Products, Inc.; Vapor Aid.
      i. Lambert Corporation; LAMBCO Skin.
      j. L&M Construction Chemicals, Inc.; E-Con.
      k. Meadows, W. R., Inc.; EVAPRE.
      l. Metalcrete Industries; Waterhold.
      m. Nox-Crete Products Group; Monofilm.
      n. Sika Corporation, Inc.; SikaFilm.
      o. Symons by Dayton Superior; Finishing Aid.
      p. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
      q. Unitex; Pro-Film.
      r. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

   1. Products:
      a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
      b. BASF Construction Chemicals – Building Systems; Kure 200.
      c. ChemMasters; Safe-Cure Clear.
      d. Conspec by Dayton Superior; W.B. Resin Cure.
      e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
      f. Edoco by Dayton Superior; Res X Cure WB.
      g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
      i. Lambert Corporation; Aqua Kure-Clear.
      j. L&M Construction Chemicals, Inc.; L&M Cure R.
l. Nox-Crete Products Group; Resin Cure E.
m. Right Pointe; Clear Water Resin.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Products:

   a. Anti-Hydro International, Inc.; AH Clear Cure WB.
   b. BASF Construction Chemicals – Building Systems; Kure-N-Seal WB.
   c. ChemMasters; Safe-Cure & Seal 20.
   d. Conspec by Dayton Superior; Cure and Seal WB.
   e. Cresset Chemical Company; Crete-Trete 309-VOC Cure & Seal.
   f. Dayton Superior Corporation; Safe Cure and Seal (J-18).
   g. Edoco by Dayton Superior; Spartan Cote WB II.
   h. Euclid Chemical Company (The), an RPM company; Aqua Cure VOX; Clearseal WB 150.
   j. Lambert Corporation; Glazecote Sealer-20.
   k. L&M Construction Chemicals, Inc.; Dress & Seal WB.
   m. Metalcrete Industries; Metcure.
   n. Nox-Crete Products Group; Cure & Seal 150E.
   o. Symons by Dayton Superior; Cure & Seal 18 Percent E.
   p. TK Products, Division of Sierra Corporation; TK-2519 WB.
   q. Vexcon Chemicals, Inc.; Starseal 309.

G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Products:

   a. BASF Construction Chemicals – Building Systems; Kure-N-Seal W.
   b. ChemMasters; Safe-Cure Clear.
   c. Conspec by Dayton Superior; High Seal.
   d. Dayton Superior Corporation; Safe Cure and Seal (J-19).
   e. Edoco by Dayton Superior; Spartan Cote WB II 20 Percent.
   f. Euclid Chemical Company (The), an RPM Company; Diamond Clear VOX; Clearseal WB STD.
   g. Kaufman Products, Inc.; SureCure Emulsion.
   h. Lambert Corporation; Glazecote Sealer-20.
   i. L&M Construction Chemicals, Inc.; Dress & Seal WB.
   k. Metalcrete Industries; Metcure 0800.
   l. Nox-Crete Products Group; Cure & Seal 200E.
   m. Symons by Dayton Superior; Cure & Seal 18 Percent E.
   n. Vexcon Chemicals, Inc.; Starseal 0800.

2.11 RELATED MATERIALS

A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

B. Sleeves and Blockouts: Formed with galvanized metal, galvanized pipe, polyvinyl chloride pipe, fiber tubes, or wood.
C. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required; of strength and character to maintain formwork in place while placing concrete.

2.12 REPAIR MATERIALS

   1. Compressive Strength: 1200 psi minimum at 1 day; 6000 psi minimum at 28 days when tested according to ASTM C 109.
   2. Bond Strength: 1800 psi minimum at 28 days when tested according to ASTM C 882 (Modified).
   3. Product / Manufacturer: SikaTop 122 Plus or SikaTop 123 Plus, Sika Corporation, or approved equal.

B. Repair Mortar – Form and Pour or Pump: Pre-packaged, cement-based, single-component, polymer-modified, silica-fume-enhanced, cementitious mortar.
   1. Compressive Strength: 3000 psi minimum at 1 day; 6500 psi at 28 days when tested according to ASTM C 109.
   2. Bond Strength: 2200 psi at 28 days when tested according to ASTM C 882 (modified).
   3. Product / Manufacturer: Sika MonoTop 611, Sika Corporation, or approved equal.

2.13 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
   2. Required average strength above specified strength:
      a. Based on a record of past performance: Determination of required average strength above specified strength shall be based on the standard deviation record of the results of at least 30 consecutive strength tests in accordance with ACI 318, Chapter 5.3 by the larger amount defined by formulas 5-1 and 5-2.
      b. Based on laboratory trial mixtures: Proportions shall be selected on the basis of laboratory trial batches prepared in accordance with ACI 318, Chapter 5.3.3.2 to produce an average strength greater than the specified strength f‘c by the amount defined in table 5.3.2.2.

      1) Proportions of ingredients for concrete mixes shall be determined by an independent testing laboratory or qualified concrete supplier.
      2) For each proposed mixture, at least three compressive test cylinders shall be made and tested for strength at the specified age. Additional cylinders may be made for testing for information at earlier ages.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 20 percent.
   4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer’s written instructions.
   1. Do not use admixtures which have not been incorporated and tested in accepted mixes.
2. Use water-reducing admixture in concrete, as required, for placement and workability.
3. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
4. Use water-reducing admixture in pumped concrete, and concrete with a water-cementitious materials ratio below 0.50.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS
A. Proportion normal-weight concrete mixture as indicated on drawings.

2.15 FABRICATING REINFORCEMENT
A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.16 FABRICATION OF EMBEDDED METAL ASSEMBLIES
A. Fabricate metal assemblies in the shop. Holes shall be made by drilling or punching. Holes shall not be made by or enlarged by burning. Welding shall be in accordance with AWS D1.1.
B. Welding of deformed bar anchors and headed stud anchors shall be done by full fusion process equal to that of TRW Nelson Stud Welding Division. A minimum of two headed studs shall be tested at the start of each production period for proper quality control. The studs shall be capable of being bent 45 degrees without failure.
C. Welding of reinforcement shall be done in accordance with AWS D1.4, using the recommended preheat temperature and electrode for the type of reinforcement being welded. Bars larger than no. 9 shall not be welded. Welding shall be subject to the observance and testing of the Testing Laboratory.
D. Metal assemblies exposed to earth, weather or moisture shall be hot dip galvanized. All other metal assemblies shall be either hot dip galvanized or painted with an epoxy paint. Repair galvanizing after welding with a Cold Galvanizing compound installed in accordance with the manufacturer's instructions. Repair painted assemblies after welding with same type of paint.

2.17 CONCRETE MIXING
A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and furnish batch ticket information.
   1. When air temperature is between 85 and 95 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 95 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION
3.1 FORMWORK
A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
1. Vertical alignment:
   a. Lines, surfaces and arises less than 100 feet in height - 1 inch.
   b. Outside corner of exposed corner columns and control joints in concrete exposed to view less than 100 feet in height - 1/2 inch.

2. Lateral alignment:
   a. Members - 1 inch.
   b. Centerline of openings 12 inches or smaller and edge location of larger openings in slabs - 1/2 inch.

3. Level alignment:
   a. Elevation of slabs-on-grade - 3/4 inch.
   d. Lintels, sills, parapets, horizontal grooves, and other lines exposed to view - 1/2 inch.

   a. 12 inch dimension or less - plus 3/8 inch to minus 1/4 inch.
   b. Greater than 12 inch to 3 foot dimension - plus 1/2 inch to minus 3/8 inch.
   c. Greater than 3 foot dimension - plus 1 inch to minus 3/4 inch.

5. Relative alignment:
   a. Stairs:
      1) Difference in height between adjacent risers - 1/8 inch.
      2) Difference in width between adjacent treads - 1/4 inch.
      3) Maximum difference in height between risers in a flight of stairs - 3/8 inch.
      4) Maximum difference in width between treads in a flight of stairs - 3/8 inch.
   b. Grooves:
      1) Specified width 2 inches or less - 1/8 inch.
      2) Specified width between 2 inches and 12 inches - 1/4 inch.
   c. Vertical alignment of outside corner of exposed corner columns and control joint grooves in concrete exposed to view - 1/4 inch in 10 feet.
   d. All other conditions - 3/8 inch in 10 feet.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   2. Class C, 1/2 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Install keyways, reglets, recesses, and the like, for easy removal.
   2. Do not use rust-stained steel form-facing material.
F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide elevation or camber in formwork as required for anticipated formwork deflections due to weight and pressures of concrete and construction loads.

H. Foundation Elements: The sides of all below grade portions of beams, pier caps, walls, and columns shall be formed straight and to the lines and grades specified. Foundation elements shall not be earth formed unless specifically indicated on the Drawings.

I. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

J. Chamfer exterior corners and edges of permanently exposed concrete.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

L. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

M. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

N. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

1. Do not apply form release agent where concrete surfaces are scheduled to receive subsequent finishes which may be affected by agent. Soak contact surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

3.2 EMBEDDED ITEMS

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

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

   a. Spacing within a bolt group: 1/8"
   b. Location of bolt group (center): 1/2"
   c. Rotation of bolt group: 5 degrees
   d. Angle off vertical: 5 degrees
   e. Bolt projection: ± 3/8"


3.3 VOID FORMS

A. Install void forms in all locations shown on the Drawings. In general, void forms shall be placed below all structural elements supported by piers to separate these elements from the earth.
B. Seal discontinuous ends of void forms and tape all joints with waterproof tape so that concrete will not enter the void space during placement of concrete. Do not leave gaps between void form sections.

C. Premanufactured void forms with circular edges shall be used around all drilled piers. Field fabrication of pier void forms is not permitted.

D. Do not allow any portion of void forms to fall within the circumference of piers causing a reduction in the bearing area.

E. Protect void forms from water. Do not install void forms during wet weather or on wet ground. Void forms which become saturated prior to placement of concrete shall be removed and replaced. Void forms shall not be wrapped in plastic, or other similar material to protect from moisture when installed.

F. Exercise care in placement of concrete to avoid collapse of void form. If void forms collapse, soil beneath the concrete shall be dug out and a proper void space shall be created by installing soil retainers on each side of element.

G. Void forms under slabs shall be protected by a layer of one-eighth inch thick protection board followed by a vapor barrier or retarder per the specifications. Do not install void forms under soil supported slabs on grade.

3.4 SOIL RETAINERS

A. Install soil retainers in straight, clean trenches at sides of void forms prior to concrete placement. The gaps between the trench and retainers must be properly positioned or backfilled prior to the placement of concrete. Do not cast the sides of concrete beams directly against the soil.

B. Affix the soil retainers to the concrete beam with adhesive, pin/washer/load, or concrete hard nails spaced on 24 inch centers.

3.5 REMOVING AND REUSING FORMS

A. General: 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, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Minimum cumulative curing times may be reduced by the use of high-early strength cement or forming systems which allow form removal without disturbing shores, but only after the Contractor has demonstrated to the satisfaction of the Architect that the early removal of forms will not cause excessive sag, distortion or damage to the concrete elements.

2. Wood forms shall be completely removed. Provide temporary openings if required.

3. Provide adequate methods of curing and thermal protection of exposed concrete if forms are removed prior to completion of specified curing time.

4. Obtaining concrete compressive strength tests for the purposes of form removal shall be the responsibility of the Contractor.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.6 VAPOR RETARDERS

A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
B. Lap joints 6 inches and seal with tape as noted below.
   1. Vapor retarder membrane seal at slabs on void forms for use with membranes that are not self-adhering to the underside of concrete slabs: Seal vapor retarder membrane to underside of slab using perimeter/seam seal tape applied continuously to perimeter of vapor retarder membrane at grade beams (3in. tape) and at the seams at interior conditions (6in. tape).
      a. Apply double-sided adhesive tape top surface of grade beam and adhere membrane to tape. Refer to the drawings for detail.
      b. Remove any dirt or debris from membrane prior to application of sealing tape.
   2. General sealing and at slabs on grade: Use manufacturer’s standard adhesive or pressure sensitive tape for sealing membrane at seams, pipe penetrations, tears, etc.

3.7 STEEL REINFORCEMENT

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

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   1. Weld reinforcing bars according to AWS D1.4, where indicated. Only steel conforming to ASTM A706 may be welded.

D. Installation tolerances:
   1. Top and bottom bars in slabs, girders, beams and joists:
      a. Members 8" deep or less: ±3/8"
      b. Members more than 8" deep: ±1/2"
   2. Concrete Cover to Formed or Finished Surfaces: ±3/8" for members 8" deep or less; ±1/2" for members over 8" deep, except that tolerance for cover shall not exceed 1/3 of the specified cover.

E. Concrete Cover: Refer to the Structural Notes.

F. Splices: Provide standard reinforcement splices by lapping and tying ends. Comply with ACI 318 for minimum lap of spliced bars where not specified on the documents.

G. Mechanical Splices: Use for splicing of bars larger than no. 11 or where no. 11 bars are spliced to larger size bars and where indicated on the drawings. Comply with manufacturer's instructions for preparation of bars and installation procedures.

H. Field Welding of Embedded Metal Assemblies: All paint and galvanizing shall be removed in areas to receive field welds. All areas where paint or galvanizing has been removed shall be field repaired with the specified paint or cold galvanizing compound, respectively.

I. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

J. 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.
3.8 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. 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 into concrete.

3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, and only if specifically noted as withheld on the batch ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

2. Water content shall not exceed the maximum specified water/cement ratio for the mix.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be 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 to not 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.

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 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.

4. Do not permit concrete to drop freely any distance greater than 20'-0" for concrete containing a high range water reducing admixture (superplasticizer) or 5'-0" for other concrete. Provide chute or tremie to place concrete where longer drops are necessary. Do not place concrete into excavations with standing water. If place of deposit cannot be pumped dry, pour concrete through a tremie with its outlet near the bottom of the place of deposit.

5. Pump priming grout shall be discarded and not used in the structure.
D. 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.
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.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 305.1 and as follows:

1. Maintain concrete temperature below 95 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

1. Housekeeping pads: Concrete fill shall be normal weight concrete (3000 psi), reinforced with 4x4-W2.1xW2.1 welded wire mesh set at middepth of pad. Trowel concrete to a dense, smooth finish. Set anchor bolts for securing mechanical or electrical equipment during pouring of concrete fill.

3.12 INSTALLATION OF NON-SHRINK GROUT UNDER BASEPLATES

A. Grout under all bearing and baseplates. Comply with manufacturer’s instructions. Do not dry pack.

B. Mixing: Use a mechanical mixer. Add only enough water to make grout placeable. Do not mix more grout than can be used in 20 minutes. Under no circumstances shall grout be retempered.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer’s written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer’s written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 CONCRETE SURFACE REPAIRS

A. Surface Defects in Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Owner's approval.

B. Contractor shall submit a detailed, descriptive procedure listing proposed pre-packaged repair materials and methods for the repair of surface defects prior to the start of repair work.

C. Patching Mortar: Mix, place and finish pre-packaged repair mortar in accordance with manufacturer's instructions.

D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, minor honeycombs and rock pockets with no exposed reinforcement, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out minor honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface, 1/4 inch deep minimum. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view using pre-packaged repair mortar so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

E. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include minor spalls, pop outs, honeycombs and rock pockets with no exposed reinforcement, crazing and cracks in excess of 0.01 inch wide that do not penetrate to reinforcement, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with patching mortar. Remove defective areas with clean, square cuts, 1/4" deep minimum. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Place, compact, and finish patching mortar to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

8. Unapproved and defective repairs shall be removed and replaced in accordance with requirements provided by the Engineer at no additional cost to the Owner.

3.15 STRUCTURAL REPAIRS

A. Structurally Defective Concrete: Structural defects include spalls, honeycombs or rock pockets with exposed reinforcement, hollow-sounding concrete, cracks that penetrate to the reinforcement or completely through concrete elements, inadequate cover over reinforcement, and other conditions that affect the structural performance or durability of the concrete as determined by the Engineer.

B. Repair structural defects in concrete in accordance with plans, specifications, details, etc. provided by the Engineer.

1. The cost of the additional services provided by the Engineer to prepare the repair documents, and to oversee the repair work shall be borne by the Contractor.

C. Unapproved and defective repairs shall be removed and replaced in accordance with requirements provided by the Engineer at no additional cost to the Owner.

3.16 CLEANUP

A. Imperfect or damaged work or any material damaged or determined to be defective before final completion and acceptance of the entire job shall be satisfactorily replaced at the Contractor's expense, and in conformity with all of the requirements of the Drawings and Specifications. Removal and replacement of concrete work shall be done in such manner as not to impair the appearance or strength of the structure in any way.

B. Cleaning: Upon completion of the work all forms, equipment, protective coverings and any rubbish resulting therefrom shall be removed from the site. After sweeping floors, wash floors with clean water. Finished concrete surfaces shall be left in a clean condition, satisfactory to the Owner.

3.17 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner may engage a special inspector and/or a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections may include:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, 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.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M.
   a. Cast and laboratory cure four cylinders for each composite sample.
      1) Do not transport field-cast cylinders until they have cured for a minimum of 24 hours.

   a. Test one cylinder at 7 days
   b. Test two cylinders at 28 days
   c. Test one cylinder at 56 days
   d. If 4" by 8" cylinders are used, provide 1 additional cylinder at each stage

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.

8. Test results shall be reported 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.

9. 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.

10. 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.
    a. When the strength level of the concrete for any portion of the structure, as indicated by cylinder tests, falls below the specified requirements, the Contractor shall provide improved curing conditions and/or adjustments to the mix design as required to obtain the required strength. If the average strength of the laboratory control cylinders falls so low as to be deemed unacceptable, the Contractor shall follow the core test procedure set forth in ACI 301, Section 1.6. Locations of core tests shall be approved by the Architect. Core sampling and testing shall be at Contractors expense.
    b. If the results of the core tests indicate that the strength of the structure is inadequate, any replacement, load testing, or strengthening as may be ordered by the Architect shall be provided by the Contractor without cost to the Owner.

11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

12. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION 033000
SECTION 033300

ARCHITECTURAL CAST-IN-PLACE CONCRETE

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 specifies cast-in-place architectural concrete including forms, reinforcement accessories, concrete materials, concrete mixture design, placement procedures, and finishes.

1.3 DEFINITIONS
   A. Architectural Cast-in-Place Concrete: Formed concrete that is exposed to view on surfaces of completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
   B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
   D. Reveal: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

1.4 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference as specified in section 013100.

1.5 ACTION SUBMITTALS
   A. Shop Drawings: Include following
      1. Form tie locations
      2. Joint locations
   B. Product Data: For each type of product indicated.
   C. Design Mixtures: For each concrete mixture as specified in Section 033000.
   D. Formwork Shop Drawings: Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.
   E. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints including construction joints.
   F. Samples: For each of the following materials:
      1. Form-facing panel.
      2. Form ties.
   G. Samples for Verification: Architectural concrete Samples, cast vertically, approximately 18 by 18 by 2 inches, of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

1.6 INFORMATIONAL SUBMITTALS
   A. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
      1. Aggregates.
   B. Material Certificates: For each of the following, signed by manufacturer:
      1. Cementitious materials.
      2. Admixtures.
      3. Form materials and form-release agents.
      4. Repair materials.
   C. Minutes of pre-installation conference.
1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
   2. Personnel performing laboratory tests shall be an 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.

C. Source Limitations for Cast-in-Place Architectural Concrete: Obtain each color, size, type, and variety of concrete material and concrete mixture from one manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 and Section 6, "Architectural Concrete."
   2. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

F. Mockups: Before casting architectural concrete, build mockups to verify selections made under sample submittals and to demonstrate typical joints, surface finish, textures, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
   2. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
   3. In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.

G. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
   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 architectural concrete to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
   2. Review concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural concrete.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for formwork and other form-facing material requirements.

B. Board Form Finish: Boards shall be Grade “A” 1 inch by 6 inch western red cedar board, not less than 8 feet in length with a 3/8 inch joint between each 1 inch by 6 inch red cedar board.

C. Form Liners: Units of face design, texture, arrangement, and configuration to match design reference sample. Furnish with manufacturer’s recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.

D. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch, minimum; non-staining; in longest practicable lengths.

E. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or S, Grade NS, that adheres to form joint substrates.

F. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.
G. Form-Release Agent: Commercially formulated colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.

H. Form Ties: Factory-fabricated, glass-fiber-reinforced plastic or removable ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch in diameter, of color selected by Architect from manufacturer’s full range.

2.2 STEEL REINFORCEMENT AND ACCESSORIES
A. General: Comply with Division 03 Section “Cast-in-Place Concrete” for steel reinforcement and other requirements for reinforcement accessories.
B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufacture according to CRSI’s “Manual of Standard Practice.”
   1. Where legs of wire bar supports contact forms, use CRSI Class 1, gray, plastic-protected or CRSI Class 2, stainless-steel bar supports.

2.3 CONCRETE MATERIALS
A. Cementitious Material: Refer to section 033000 “Cast-in-Place Concrete.”

2.4 ADMIXTURES
B. Chemical Admixtures: Comply with Section 033000 CAST IN PLACE CONCRETE
C. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, non-fading, and resistant to lime and other alkalis.
   1. Color: As scheduled.
D. Comply with Section 033000, CAST IN PLACE CONCRETE

2.5 REPAIR MATERIALS
A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
   1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 CONCRETE MIXTURES, GENERAL
A. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
B. Comply with Section 033000 Cast In Place Concrete
C. Color Pigment: Add color pigment to concrete mixture according to manufacturer’s written instructions and to result in hardened concrete color consistent with approved mockup.

2.7 CONCRETE MIXING
A. Ready-Mixed Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and furnish batch ticket information.
   1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
   2. 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.
PART 3 - EXECUTION

3.1 FORMWORK
   A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for formwork, embedded items, and
      shoring and re-shoring.
   B. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.
   C. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete
      surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
      1. Class B, 1/4 inch.
   D. Fabricate forms to result in cast-in-place architectural concrete that complies with ACI 117, "Specifications
      for Tolerances for Concrete Construction and Materials."
   E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush
      or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined
      surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and
      the like, for easy removal.
      1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent
         cement paste leakage.
      2. Do not use rust-stained steel form-facing material.
   F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is
      inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of
      concrete mortar. Locate temporary openings in forms at inconspicuous locations.
   G. Chamfer exterior corners and edges of cast-in-place architectural concrete.
   H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in
      the Work. Determine sizes and locations from trades providing such items.
   I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other
      debris just before placing concrete.
   J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain
      proper alignment.
   K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions,
      before placing reinforcement.

3.2 REINFORCEMENT AND INSERTS
   A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for fabricating and installing steel
      reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete
      placement.
   B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.3 REMOVING AND REUSING FORMS
   A. General: Comply with Division 03 Section "Cast-in-Place Concrete"
   B. Formwork for sides of 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, if
      concrete is hard enough to not be damaged by form-removal operations and curing and protection
      operations are maintained.
      1. Schedule form removal to maintain surface appearance that matches approved mockups.
      2. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
   C. Leave formwork for structural elements that support weight of concrete in place until concrete has
      achieved 28-day design compressive strength. Remove forms only if shores have been arranged to
      permit removal of forms without loosening or disturbing shores.
   D. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or
      otherwise damaged form-facing material. Apply new form-release agent.
   E. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and
      secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces.

3.4 JOINTS
   A. Construction Joints: Install construction joints true to line with faces perpendicular to surface plane of cast-
      in-place architectural concrete 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.
      2. Locate horizontal joints in columns at underside of floors, slabs, beams, and girders and at the top
         of footings or floor slabs.
3. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

B. Contraction Joints: Form weakened-plane contraction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

3.5 CONCRETE PLACEMENT
A. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.
B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
C. 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.
D. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
   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 into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.
E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
   4. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.
F. Hot-Weather Placement: Comply with ACI 301 and as follows:
   1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.6 FINISHES, GENERAL
A. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.
B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
   1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
C. Maintain uniformity of special finishes over construction joints, unless otherwise indicated.

3.7 AS-CAST FORMED FINISHES
A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects.
B. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
   1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

3.8 CONCRETE PROTECTING AND CURING
A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.
B. Begin curing cast-in-place architectural concrete immediately after removing forms from concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:

1. Moisture Curing: Keep exposed surfaces of cast-in-place architectural concrete continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.

3. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 FIELD QUALITY CONTROL
   A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for field quality-control requirements.

3.10 REPAIRS, PROTECTION, AND CLEANING
   A. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.
   1. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to Architect's approval.

   B. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.

   C. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.

   D. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

   E. Wash and rinse surfaces according to concrete finish applicator's written recommendations. Protect other Work from staining or damage due to cleaning operations.
   1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION
SECTION 033500
CONCRETE FLOOR FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Finishing slabs-on-void boxes and monolithic floor slabs.
   2. Surface treatment with concrete sealer.

B. Related Sections include the following:
   1. Division 3 Section “Cast-in-Place Concrete” for concrete slab construction and finish.
   2. Division 5 Section “Expansion Joint Assemblies”
   3. Division 7 Section “Joint Sealers”
   4. Division 9 Section “Ceramic Tile” for medium-set and thickset mortar beds for tile.

1.3 REFERENCES

A. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.

1. ACI 301 - Specifications for Structural Concrete for Buildings
2. ACI 302 - Guide for Concrete Floor and Slab Construction

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

B. Submittals

1. Product Data: Submit manufacturer's data showing compliance with the specifications for the following products:
   a. Sealer

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

1. The Contractor shall call a meeting to review the detailed requirements for floor construction, including the concrete placing techniques, finishing techniques, curing techniques, and the application of floor finishing materials. All contractors involved in the floor installation shall attend the conference.
2. The Contractor shall notify the Owner, Architect and the Structural Engineer at least 10 business days prior to the scheduled date of the conference.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2.2 FLOOR AND SLAB TREATMENTS

A. Penetrating sealer:

1. Penetrating sealer shall be a low viscosity, urethane based sealer having at least 35 percent solids. Acceptable products include "Iso-Flex 611", by Master Builders, "Eucothane" by the Euclid Chemical Company, or approved equal.

PART 3 - EXECUTION

3.1 FINISHING FLOORS AND SLABS

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

B. Concrete slabs shall be finished as specified below, within the tolerances specified elsewhere in this Section.

1. Highway straightedges are recommended for use in lieu of bullfloats for all slab placement and finishing operations.
2. Screeding: Immediately after placing, slab shall be vibrated and struck off true by double screeding to the required level, at or below the elevation or grade of the finished slabs as indicated on the Drawings. Vibrators shall not be used to spread the concrete. When camber is indicated for slabs supported on formwork, screed to the required camber. Fixed screed guides are recommended where specified surface tolerance exceeds FF25/FL20.
3. Floating: Immediately after screeding, before any excess bleed water is present on the surface, float the surface using long-handled bull floats or darbies.
4. Straightedging: Immediately after screeding and before excess bleed water is present on the surface, straighten the surface using a highway straightedge.
5. Edging and jointing, where required, shall be done after bleed water has evaporated and before further finishing.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restrafighten, cut down high spots, and fill low spots. Repeat float passes and restrafightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish.
2. Locations: All concrete surfaces under waterproofing membrane, setting beds for brick, mud-set tile, pavers, or terrazzo, and noncomposite topping slabs.
D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Locations: Exposed concrete floors not otherwise specified, concrete surfaces under carpets, vinyl tile, thin set tile, wood flooring, elastomeric coatings, and painted concrete floors, and roof slabs that are future floors.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.2 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Follow manufacturers written instructions for minimum curing time before application.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.3 SEALED FLOOR TREATMENTS

A. Apply specified penetrating sealer to sealed floor areas after curing is complete. Apply uniformly at rate of coverage recommended by the manufacturer for effective absorption, using sprayer, brush, or roller. Curing compound, if used, must be compatible with penetrating sealer.

3.4 CONCRETE FINISH MEASUREMENT AND TOLERANCES

A. All floors are subject to measurement for flatness and levelness and shall comply with the following:

1. Slabs shall be flat within a tolerance of 5/16" in 10'-0" when tested with a ten foot long straightedge. Apply straightedge to the slab at 3'-0" intervals in both directions, lapping straightedge 3'-0" on areas previously checked. Low spots shall not exceed the above dimension anywhere along the straightedge. Flatness shall be checked the next work day after finishing.
2. Slabs shall be level within a tolerance of plus or minus 1/4" in 10'-0", not to exceed 3/4" total variation, anywhere on the floor, from elevations indicated on the Drawings. Levelness shall be checked on a 10'-0" grid using a level after removal of forms.
B. Floor Elevation Tolerance Envelope:

1. The acceptable tolerance envelope for absolute elevation of any point on the slab surface, with respect to the elevation shown on the Drawings, is as follows:

   b. Top surfaces of all other slabs: +/- 3/4"
   c. Slabs specified to slope shall have a tolerance from the specified slope of 3/8" in 10'-0" at any point, up to 3/4" from theoretical elevation at any point.

3.5 REPAIRS

A. Remedial Measures for Slab Finish Construction not Meeting Specified Tolerances:

1. Application of Remedial Measures. Remedial measures specified herein are required whenever either or both of the following occur:

   a. The composite overall values of flatness or levelness of any test section or the entire floor installation measure less than specified values.
   b. Any individual test sample (line of measurements) measures less than the specified absolute minimum flatness or levelness value.

2. Modification of Existing Surface:

   a. If, in the opinion of the Architect or Owner's representative, all or any portion of the substandard work can be repaired without sacrifice to the appearance or serviceability of the area, the Contractor shall immediately undertake the approved repair method.
   b. The Contractor shall submit for review and approval a detailed work plan of the proposed repair showing areas to be repaired, method of repair, and time required to make the repair.
   c. Repair method(s), at the sole discretion of the Architect or Owner's Representative, may include grinding (floor stoning), planing, retopping with specified floor leveling compound, or any combination of the above.
   d. All repair work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.

3. Removal and Replacement:

   a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work cannot be satisfactorily repaired without sacrifice to the appearance or serviceability of the area, the Contractor shall remove and replace the defective work as directed.
   b. Replacement sections may be retested for compliance at the discretion of the Architect/Engineer or Owner's Representative.
   c. All replacement work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.

END OF SECTION 033500
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 hydraulic-cement-based, polymer-modified, self-leveling underlayment for application below interior floor coverings and repair of cast in place concrete floors.
B. Related Sections:
   1. Division 09 Sections for patching and leveling compounds applied with floor coverings.

1.3 QUALITY ASSURANCE
A. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment products required for this Project.
B. Product Compatibility: Manufacturers of underlayment and floor-covering systems certify in writing that products are compatible.
C. Fire-Resistance Ratings: Where indicated, provide hydraulic-cement underlayment systems identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
D. Sound Transmission Characteristics: Where indicated, provide hydraulic-cement underlayment systems identical to those of assemblies tested for STC and IIC ratings per ASTM E 90 and ASTM E 492 by a qualified testing agency.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

1.5 PROJECT CONDITIONS
A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.
   1. Place hydraulic-cement-based underlayments only when ambient temperature and temperature of substrates are between 50 and 80 deg F.

1.6 COORDINATION
A. Coordinate application of underlayment with requirements of floor-covering products and adhesives, specified in Division 09 Sections, to ensure compatibility of products.

PART 2 - PRODUCTS

2.1 HYDRAULIC-CEMENT-BASED UNDERLAYMENTS
A. Underlayment: Hydraulic-cement-based, polymer-modified, self-leveling product that can be applied in minimum uniform thickness of 1/4 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ardex; K-15 Self-Leveling Underlayment Concrete.
      b. Dayton Superior Corporation; EconoLevel.
      c. Euclid Chemical Company (The); Super Flo-Top Level Magic TAMMS SLU.
      d. L&M Construction Chemicals, Inc.; Levelex.
      e. MAPEI Corporation; Novoplan Easy.
   2. Cement Binder: ASTM C 150, portland cement, or hydraulic or blended hydraulic cement as defined by ASTM C 219.
   3. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C 109.
   4. Underlayment Additive: Resilient-emulsion product of underlayment manufacturer, formulated for...
use with underlayment when applied to substrate and conditions indicated.

B. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch; or coarse sand as recommended by underlayment manufacturer.
   1. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.

C. Water: Potable and at a temperature of not more than 70 deg F.

D. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates, with Installer present, for conditions affecting performance.
      1. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. General: Prepare and clean substrate according to manufacturer's written instructions.
      1. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
      2. Fill substrate voids to prevent underlayment from leaking.

   B. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.

3.3 APPLICATION
   A. General: Mix and apply underlayment components according to manufacturer's written instructions.
      1. Close areas to traffic during underlayment application and for time period after application recommended in writing by manufacturer.
      2. Coordinate application of components to provide optimum underlayment-to-substrate and intercoat adhesion.

   B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

   C. Apply underlayment to produce uniform, level surface.
      1. Apply a final layer without aggregate to product surface.
      2. Feather edges to match adjacent floor elevations.

   D. Cure underlayment according to manufacturer's written instructions. Prevent contamination during application and curing processes.

   E. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.

   F. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.

3.4 PROTECTION
   A. Protect underlayment from concentrated and rolling loads for remainder of construction period.

END OF SECTION
SECTION 042000
UNIT MASONRY

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Concrete masonry units.
      2. Face brick.
      3. Mortar and grout.
      4. Steel reinforcing bars.
      5. Masonry joint reinforcement.
      6. Ties and anchors.
      7. Embedded flashing.
      8. Miscellaneous masonry accessories.

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

1.4 PERFORMANCE REQUIREMENTS
   A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
      1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.5 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For the following:
      1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
      2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
   C. Samples:
      1. Face brick, in the form of straps of five or more bricks.
      2. Special brick shapes.
      4. Weep holes/vents.

1.6 INFORMATIONAL SUBMITTALS
   A. Material Certificates: For each type and size of the following:
      1. Masonry units.
         a. Include data on material properties and material test reports substantiating compliance with requirements.
         b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
         c. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
      2. Cementitious materials. Include brand, type, and name of manufacturer.
      3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
      4. Grout mixes. Include description of type and proportions of ingredients.
      5. Reinforcing bars.
      7. Anchors, ties, and metal accessories.
B. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

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

1.7 QUALITY ASSURANCE

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockups for each type of exposed unit masonry construction in sizes approximately 60 inches long by 48 inches high by full thickness, including face and backup wythes and accessories.
      a. Include a sealant-filled joint at least 16 inches long in each exterior wall mockup.
      b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
      c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
   2. Protect accepted mockups from the elements with weather-resistant membrane.
   3. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
      a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
      b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.8 DELIVERY, STORAGE, AND HANDLING

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

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

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

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

1.9 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day’s work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.


PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL
A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS
A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
   2. Provide square-edged units for outside corners unless otherwise indicated.
B. CMUs: ASTM C 90.
   1. Density Classification: Lightweight.
   2. Exposed Faces: Provide color and texture matching the range represented by Architect’s sample.
   3. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

2.3 MASONRY LINTELS
A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 BRICK
A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
   3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
B. Clay Face Brick: Facing brick complying with ASTM C 216.
   1. Products: As selected by Architect.
   2. Grade: SW.
   3. Type: FBX.
   4. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3350psi.
   5. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
   6. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated “not effloresced.”
   7. Size: As selected by Architect.
2.5 MORTAR AND GROUT MATERIALS
A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.
Provide natural color or white cement as required to produce mortar color indicated.
B. Hydrated Lime: ASTM C 207, Type S.
C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Davis Colors; True Tone Mortar Colors.
E. Aggregate for Mortar: ASTM C 144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
F. Aggregate for Grout: ASTM C 404.
G. Water: Potable.
H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Euclid Chemical Company (The); Accelguard 80.
      c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

2.6 REINFORCEMENT
A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
   1. Exterior Walls: Hot-dip galvanized, carbon steel.
   5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.7 TIES AND ANCHORS
A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
D. Adjustable Masonry-Veneer Anchors (for use with continuous cavity insulation):
   1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to metal studs, and as follows:
      a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
      2. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section. Where continuous insulation occurs outboard of metal studs, provide anchor with prongs to properly transfer load to studs.
         a. Products: Subject to compliance with requirements, provide one of the following:
            1) Hohmann & Barnard, Inc.; 2 Seal Thermal Wing Nut Anchor.
            2) Heckmann #75 Pos-l-Tie ThermalClip.
      3. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 diameter by length required to penetrate steel
2.8 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA’s "Architectural Sheet Metal Manual" and as follows:
   1. Stainless Steel: ASTM A240 or ASTM A666, Type 304, 0.016 inch thick.
   2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
   3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of wall to provide an integral mortar bond.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cheney Flashing Company.
         2) Hohmann & Barnard, Inc.
         3) Keystone Flashing Company, Inc.
   4. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.

B. Flexible Flashing: Use the following unless otherwise indicated:
   1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
         2) Dayton Superior Corporation, Dur-O-Wall Division; Dur-O-Barrier Thru-Wall Flashing.
         4) Heckmann Building Products Inc.: No. 82 Rubberized-Asphalt Thru-Wall Flashing.
         5) Hohmann & Barnard, Inc.; Textroflash.
         6) W. R. Meadows, Inc.; Air-Shield Thru-Wall Flashing.
         7) Polyguard Products, Inc.; Polyguard 300.
      b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

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

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Mortar Net USA, Ltd.; Blok-Flash.

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

2.9 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
   c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.

D. Weep/Vent Products: Use one of the following unless otherwise indicated:
1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Advanced Building Products Inc.; Mortar Maze weep vent.
      2) Blok-Lok Limited; Cell-Vent.
      3) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
      4) Heckmann Building Products Inc.; No. 85 Cell Vent.
      5) Hohmann & Barnard, Inc.; Quadro-Vent.
   b. Wire-Bond; Cell Vent.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Advanced Building Products Inc.; Mortar Break.
   b. Archovations, Inc.; CavClear Masonry Mat.
   c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
   d. Mortar Net USA, Ltd.; Mortar Net.
2. Provide one of the following configurations:
   a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep that prevent clogging with mortar droppings.

F. Cavity Wall Insulation: Refer to section 072100 "Thermal Insulation" for cavity wall insulation.

2.10 MORTAR AND GROUT MIXES

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

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For masonry below grade or in contact with earth, use Type M.
   2. For reinforced masonry, use Type S.
   3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
   1. Pigments shall not exceed 10 percent of portland cement by weight.

E. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
   3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL
A. Thickness: Build cavity walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
B. Build chases and recesses to accommodate items specified in this and other Sections.
C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
E. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
F. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. 1. Mix units from several pallets or cubes as they are placed.

3.3 TOLERANCES
A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
   2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
   3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
B. Lines and Levels:
   1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
   2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
   3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
   4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
   5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
   6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
   7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
C. Joints:
   1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
   2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
   3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
   4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
   5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.
3.4 LAYING MASONRY WALLS
A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond or bond pattern indicated on Drawings if different; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above.
   2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
   3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
   4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING
A. Lay hollow CMUs as follows:
   1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or sluice head joints.

C. Set trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
   1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
   2. Allow cleaned surfaces to dry before setting.
   3. Wet joint surfaces thoroughly before applying mortar.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
   1. For glazed masonry units, use a nonmetallic jointer 3/4 inch or more in width.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 ANCHORING MASONRY VENEERS
A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
   1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
   2. Embed tie sections in masonry joints. Provide for continuous insulation and not less than 1 inch of air space between back of masonry veneer and face of continuous insulation.
   3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally (or 12 inches on center vertically and 32 inches on center horizontally) with not less than 1 anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

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

3.8 CONTROL AND EXPANSION JOINTS
A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
B. Form control joints in concrete masonry using one of the following methods:
  1. Install preformed control-joint gaskets designed to fit standard sash block.
  2. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
C. Form expansion joints in brick as follows:
  1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
  2. Build flanges of factory-fabricated, expansion-joint units into masonry.
  3. Build in compressible joint fillers where indicated.
  4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."
D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.
  1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.9 LINTELS
A. Install steel lintels where indicated.
B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS
A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
B. Install flashing as follows unless otherwise indicated:
  1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
  2. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches as required by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
  3. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
3.11 REINFORCED UNIT MASONRY INSTALLATION
A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches.

3.12 FIELD QUALITY CONTROL
A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
B. Inspections: Level 1 special inspections according to the "International Building Code."
   1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
   2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
   3. Place grout only after inspectors have verified proportions of site-prepared grout.
C. Testing Prior to Construction: One set of tests.
D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.
F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
H. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content, and compressive strength.
I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.
J. Prism Test: For each type of construction provided, according to ASTM C 1314 at 28 days.

3.13 REPAIRING, POINTING, AND CLEANING
A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
B. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before toothing joints.
C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   4. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.14 MASONRY WASTE DISPOSAL
A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION
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 types of dimension stone:
      1. Panels individually anchored with mechanical anchors to cold-formed metal framing.
      2. Trim units, including base, water table and coping as indicated.

1.3 DEFINITIONS
   A. Definitions contained in ASTM C 119 apply to this Section.
   B. Dimension Stone Cladding System: An exterior wall covering system consisting of dimension stone panels and trim together with anchors, backup structure, fasteners, and sealants used to secure the stone to building structure and to produce a weather-resistant covering.
      1. Backup structure includes concrete foundations.

1.4 PERFORMANCE REQUIREMENTS
   A. General: Design stone anchors and anchoring systems according to ASTM C 1242.
   B. Structural Performance: Provide dimension stone cladding system capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   C. Wind Loads: Determine loads based on the following minimum design wind pressures:
      1. Uniform pressure as indicated on structural drawings.
   D. Thermal Movements: Provide dimension stone cladding system that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing displacement of stone, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
   E. Safety Factors for Stone: Design dimension stone cladding system to withstand loads indicated without exceeding allowable working stress of stone determined by dividing stone's average ultimate strength, as established by testing, by the following safety factors:
      2. Safety Factor for Concentrated Stresses: 10 for stone.
   F. Design stone anchors to withstand loads indicated without exceeding allowable working stresses established by the following:
      1. For Cold-Formed Steel: AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
   G. Provisions for Fabrication and Erection Tolerances: Allow for fabrication and erection tolerances of building's structural system. Structural-steel fabrication and erection tolerances are specified in Division 05 Section "Structural Steel Framing."
   H. Provision for Deflection of Building Structure: Allow for the following:
      1. Deflection due to Weight of Dimension Stone Cladding System: Allow for 1/4-inch vertical deflection in 20-foot span of structural members supporting dimension stone cladding system.
      2. Live Load Deflection: Allow for 1/4-inch vertical deflection, in 20-foot span of structural members supporting dimension stone cladding system, due to live loads imposed on building's structural frame after stone installation.
   I. Leakage Resistance, Water and Air: Provide dimension stone cladding system that complies with the following:
      1. Air Infiltration: Not more than 0.06 cfm/sq. ft. of wall area, as measured by testing mockup per ASTM E 283 at a differential pressure of 1.57 lbf/sq. ft.
      2. Water Penetration: No uncontrolled water penetration beyond plane of back of dimension stone cladding system that is not contained or drained back to exterior, as measured by testing mockup per ASTM E 331 at a differential pressure of 20 percent of positive design wind load, but not less than 10 lbf/sq. ft.

DIMENSION STONE CLADDING

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J. Control of Corrosion and Staining: Prevent galvanic and other forms of corrosion as well as staining by isolating metals and other materials from direct contact with incompatible materials. Use materials that do not stain exposed surfaces of stone and joint materials.

1.5 SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and other manufactured products indicated.

B. Shop Drawings: Show fabrication and installation details for dimension stone cladding system, including dimensions and profiles of stone units.
   1. Show locations and details of joints both within dimension stone cladding system and between dimension stone cladding system and other construction.
   2. Include details of sealant joints.
   3. Show locations and details of anchors and backup structure.
   4. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation, licensed to practice in the project location.

C. Samples for Initial Selection: For joint materials involving color selection from manufacturer’s full range of color selections available

D. Stone Samples for Verification: Sets for each color, grade, finish, and variety of stone required; not less than 12 inches square.
   1. Sets shall consist of at least three Samples, exhibiting extremes of the full range of color and other visual characteristics expected and will establish the standard by which stone will be judged.

E. Sealant Samples for Verification: For each type and color of joint sealant required.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual experienced in installing dimension stone cladding systems similar in material, design, and extent to that indicated for this Project, whose work has a record of successful in-service performance.

B. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate dimension stone cladding systems similar to that required for this Project and whose products have a record of successful in-service performance.
   1. Fabricator’s responsibilities include fabricating dimension stone cladding and providing professional engineering services needed to assume engineering responsibility.
   2. Engineering Responsibility: Comprehensive engineering analysis by a qualified professional engineer.

C. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.

D. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry with resources to provide materials of consistent quality in appearance and physical properties.
   1. For stone types that include same list of varieties and sources, provide same variety from same source for each.

E. Source Limitations for Other Materials: Obtain each type of stone accessory, sealant, and other material from a single manufacturer for each product.

F. Pre-construction Stone Testing: Engage a qualified independent testing agency to perform preconstruction testing indicated below.
   1. Retesting of materials that fail to meet specified requirements shall be done at Contractor’s expense.
   2. Furnish test specimens that are representative of materials proposed for incorporation into the Work.
   3. Physical Property Tests: For each stone variety proposed for use on Project, tested for compliance with physical property requirements, other than abrasion resistance, according to referenced ASTM standards.
   4. Anchorage Tests: For each combination of stone variety, orientation of cut, finish, and anchor type proposed for use on Project, tested according to ASTM C 1354.
   5. Anchoring System Mockup Tests: For performance of stone anchoring system, evaluated for compliance with requirements by mockup testing per ASTM C 1201, Procedure B, with a maximum test load equal to 3 times the design load.
   6. Cladding System Mockup Tests: For performance of dimension stone cladding system, evaluated for compliance with requirements by mockup testing per ASTM E 72, with a maximum test load equal to 3 times the design load.
   7. Contractor is required to build test mockups of representative portion of dimension stone cladding system corresponding to area indicated on Drawings. Build test mockups at testing agency’s
facilities from same materials proposed for Project, using installers who will perform same tasks for Project.

G. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Division 07 Section "Joint Sealants," samples of materials that will contact or affect joint sealants.


I. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. If not shown on drawings, provide mockup as described below. Coordinate with Architect prior to building mock-up

1. Build mockups of typical exterior wall with dimension stone cladding, approximately 72 inches long by 48 inches high.
   a. Show typical components, attachments to building structure, and methods of installation.
   b. Include window opening with stone returns and trim.
   c. Include sealant-filled joint complying with requirements in Division 07 Section "Joint Sealants."
   d. Include water repellent, if applicable.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect, in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.

1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

2. Store stone on wood skids or pallets with non-staining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

B. Mark stone units, on surface that will be concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels so that they are right side up when units are installed.

1.8 PROJECT CONDITIONS

A. Protect dimension stone cladding during erection as follows:

1. Cover tops of dimension stone cladding installation with non-staining, waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of 24 inches down both sides and hold securely in place.

2. Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials without damaging stone.

3. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.

4. Protect sills, ledges, and projections from mortar and sealant droppings.

1.9 COORDINATION

A. Coordinate installation of inserts that are to be embedded in concrete or masonry, flashing reglets, and similar items to be used by dimension stone cladding Installer for anchoring, supporting, and flashing of dimension stone cladding system. Furnish setting drawings, templates, and directions for installing such items and deliver to Project site in time for installation.

B. Time delivery and installation of dimension stone cladding to avoid extended on-site storage and to coordinate with work adjacent to dimension stone cladding.

PART 2 - PRODUCTS

2.1 DIMENSION STONE CLADDING (F-1)

A. Type, Color, Description, Cut, Finish, Size and Thickness: As scheduled.

B. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

C. Limestone: Comply with ASTM C 568.

2.2 BACKUP STRUCTURE

A. Steel Stud Frames: Galvanized-steel wall framing complying with Section 054000 "Cold-Formed Metal Framing."

DIMENSION STONE CLADDING

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B. Cast in Place Concrete as indicated in Section 033000.

2.3 ANCHORS AND FASTENERS

A. Fabricate anchors, including shelf angles and clips from stainless steel, ASTM A 240 or ASTM A 666, Type 304; temper as required to support loads imposed without exceeding allowable design stresses. Fabricate dowels and pins for anchors from stainless steel, ASTM A 276, Type 304.

B. Postinstalled Anchor Bolts for Concrete and Masonry: Either torque controlled expansion anchors or chemical anchors (as determined by design) made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 for bolts and nuts; ASTM A 240, ASTM A 276, or ASTM A 666, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

2.4 STONE ACCESSORIES

A. Setting Shims: Strips of resilient plastic or vulcanized neoprene, Type A Shore durometer hardness of 50 to 70, non-staining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.

B. Sealants for Joints in Dimension Stone Cladding: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and do not stain stone.

1. Colors: As scheduled, or to be selected by Architect from Manufacturer's full color range.

C. Sealant for Filling Kerfs: Same sealant used for joints in dimension stone.

2.5 STONE FABRICATION

A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.

1. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."

B. Control depth of stone and back check to maintain minimum clearance of 1-1/2 inches (or as indicated on drawings) between backs of stone units and surfaces or projections of structural members, fireproofing (if any), backup walls, and other work behind stone.

C. Dress joints (bed and vertical) straight and at right angle to face, unless otherwise indicated. Shape beds to fit supports.

D. Cut and drill sinkages and holes in stone for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone securely in place.

E. Finish exposed faces and edges of stone to comply with requirements indicated for finish and to match approved samples and mockups.

F. Quirk-miter corners, unless otherwise indicated; provide for cramp anchorage in top and bottom bed joints of corner pieces.

G. Cut stone to produce uniform joints 3/8 inch wide and in locations indicated.

H. Contiguous Work: Provide chases, reveals, reglets, openings, and similar features as required to accommodate contiguous work.

I. Fabricate molded work, including washes and drips, to produce stone shapes with a uniform profile throughout entire unit length, with precisely formed arris slightly eased to prevent snipping, and with matching profile at joints between units.

1. Produce moldings and molded edges with machines that use abrasive shaping wheels made to reverse contour of molding shape.

J. Clean backs of stone to remove rust stains, iron particles, and stone dust.

K. Inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

1. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved samples and mockups.

2.6 SOURCE QUALITY CONTROL

A. Source Quality-Control Testing Service: Engage a qualified independent testing agency to perform source quality-control testing indicated below.

1. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.
2. Furnish test specimens randomly selected from same blocks as actual materials proposed for incorporation into the Work.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine surfaces to receive dimension stone cladding and conditions under which dimension stone cladding will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of dimension stone cladding.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING DIMENSION STONE CLADDING, GENERAL
A. Before setting stone clean surfaces that are dirty or stained by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.
B. Coat limestone with dampproofing to extent indicated below:
   1. Stone at Grade: Beds, joints, and back surfaces to at least 12 inches above finish-grade elevations.
   2. Stone Extending below Grade: Beds, joints, back surfaces, and face surfaces below grade.
C. Execute dimension stone cladding installation by skilled mechanics and employ skilled stone fitters at Project site to do necessary field cutting as stone is set.
   1. Use power saws with diamond blades to cut stone. Produce lines cut straight and true, with edges eased slightly to prevent snipping.
D. Contiguous Work: Provide reveals, reglets, and openings as required to accommodate contiguous work.
E. Set stone to comply with requirements indicated on Drawings and Shop Drawings. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.
F. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.
   1. Place weep holes in joints where moisture may accumulate, including base of cavity walls, above shelf angles, and flashing. Locate weep holes at intervals not exceeding 24 inches.
   2. Place vents in cavity walls at tops of cavities, below shelf angles and flashing, and at intervals not exceeding 60 inches horizontally.
   3. Use plastic weep hole/vents.
G. Keep cavities open where unfilled space is indicated between back of stone units and backup wall; do not fill cavities with mortar or grout.
   1. Place weep holes in joints where moisture may accumulate, including base of cavity walls, above shelf angles, and flashing. Locate weep holes at intervals not exceeding 24 inches.
   2. Place vents in cavity walls at tops of cavities, below shelf angles and flashing, and at intervals not exceeding 20 feet vertically. Locate vents in joints at intervals not exceeding 60 inches horizontally.
   3. Use plastic weep hole/vents.

3.3 SETTING MECHANICALLY ANCHORED DIMENSION STONE CLADDING
A. Attach anchors securely to stone and to backup surfaces. Comply with recommendations in ASTM C 1242.
B. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with sealant indicated for filling kerfs.
C. Set stone supported on clips or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths and to prevent point loading of stone on anchors. Hold shims back from face of stone a distance at least equal to width of joint.
D. Anchor stone masonry to metal-stud framing with mechanical anchors.

3.4 INSTALLATION TOLERANCES
A. Variation from Plumb: For vertical lines and surfaces of walls, do not exceed 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch in 40 feet or more. For external corners, corners and jambs within 20 feet of an entrance, expansion joints, and other conspicuous lines, do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch in 40 feet or more.
B. Variation from Level: For lintels, sills, water tables, parapets, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch maximum.
C. Variation of Linear Building Line: For positions shown in plan and related portions of walls and partitions, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.
D. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus 1/4 inch.

E. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1/8 inch or a quarter of nominal joint width, whichever is less. For joints within 60 inches of each other, do not vary more than 1/8 inch or a quarter of nominal joint width, whichever is less from one to the other.

F. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 1/16-inch difference between planes of adjacent units.

3.5 ADJUSTING AND CLEANING

A. Remove and replace broken, chipped, stained, or otherwise damaged stone, defective joints, and dimension stone cladding that does not match approved samples and mockups. Damaged stone may be repaired if Architect approves methods and results.

B. Replace in a manner that results in dimension stone cladding's matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean dimension stone cladding as work progresses. Remove excess sealant and smears as sealant is installed.

D. Final Cleaning: Clean dimension stone cladding no fewer than six days after completion of pointing and sealing, using clean water and stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning agents containing caustic compounds or abrasives, or other materials or methods that could damage stone.

END OF SECTION
SECTION 044300

STONE MASONRY VENEER

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes the following applications of anchored limestone veneer masonry:
   1. Anchored to cold-formed metal framing and sheathing.
B. Products installed, but not furnished, in this Section include:
   Steel lintels and shelf angles for stone masonry specified in Division 05 Section "Metal Fabrications."

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
   1. For stone varieties proposed for use on Project, include test data indicating compliance with physical properties required by referenced ASTM standards.
B. Samples for Initial Selection: Full range for colored mortar and other items involving color selection.
C. Samples for Verification:
   1. For each stone type indicated. Include at least three samples in each set for each type of stone, exhibiting extremes of the full range of color and other visual characteristics expected in completed Work. Samples will establish the standard by which stone provided will be judged.
   2. For each color of mortar required. Label Samples to indicate types and amounts of pigments used.
D. Qualification Data: For qualified Installer.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters. Similar project size, scope and complexity of work.
B. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from one quarry, whether specified in this Section or in another Section of the Specifications, with resources to provide materials of consistent quality in appearance and physical properties.
C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
D. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of typical wall area as shown on Drawings. If not shown on drawings, provide mockup based on the following below:
   2. Build mockups for each type of stone masonry in sizes approximately 48 inches long by 48 inches high by full thickness, including face, backup framing and accessories.
      a. Include stone coping at top of mockup.
      b. Include a sealant-filled joint at least 16 inches long in mockup.
      c. Include through-wall flashing installed for a 24-inch length by 61-inch width, match actual conditions of project, with a 12-inch length of flashing left exposed to view (omit stone masonry above half of flashing).
      d. Include studs, sheathing, veneer anchors, flashing, and weep holes in exterior masonry-veneer wall mockup.
   3. Protect accepted mockups from the elements with weather-resistant membrane.
   4. Approval of mockups is for color, texture, and blending of stone; relationship of mortar and sealant colors to stone colors; tooling of joints; and aesthetic qualities of workmanship.
      a. Approval of mockups is also for other material and construction qualities Architect specifically approves in writing.
      b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
E. Preinstallation Conference: Conduct conference at Project site.
1.5 DELIVERY, STORAGE, AND HANDLING
A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 PROJECT CONDITIONS
A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining the face of stone masonry.
   1. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on the ground and over the wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.
C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

1.7 COORDINATION
A. Advise installers of other work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone masonry.

PART 2 - PRODUCTS

2.1 DRESSED STONE MASONRY VENEER (F-2)
A. Finely Dressed (cut, worked) Stone Masonry: Type, Color, Cut, Finish Size and Thickness: As indicated on Drawings.
B. Limestone: Comply with ASTM C 568.
   1. Products: As scheduled.

2.2 MORTAR MATERIALS
A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.
B. Hydrated Lime: ASTM C 207, Type S.
C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or III, and hydrated lime complying with ASTM C 207.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Essroc, Italcementi Group; Capitol PCL Blend.
      b. Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
      c. Lafarge North America; Eaglebond.
      d. Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
D. Aggregate: ASTM C 144 and as follows:
   1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 sieve.
E. Water: Potable.
2.3 VENEER ANCHORS

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


B. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches, through stone masonry and with at least 5/8-inch cover on outside face.

C. Wire Veneer Anchors: Wire ties formed from W1.7 or 0.148-inch-diameter, hot-dip galvanized steel wire.

1. Ties are bent in the form of loops with legs not less than 15 inches in length and with last 2 inches bent at 90 degrees.
2. Ties are bent in the form of rectangular loops with ends bent downward for inserting into eyes projecting from masonry joint reinforcement specified in Division 04 Section "Unit Masonry."
3. Ties are bent in the form of triangular loops designed to be attached to masonry joint reinforcement specified in Division 04 Section "Unit Masonry" with vertical wires passing through ties and through eyes projecting from masonry joint reinforcement.

D. Adjustable, Thermally Broken, Screw-Attached, Veneer Anchors: Units consisting of a wire tie section and a metal anchor section for attachment over sheathing to metal studs, and as follows:

1. Anchor Section: Zinc-alloy barrel section with flanged head with eye and corrosion-resistant, self-drilling screw. Eye designed to receive wire tie and to serve as head for drilling fastener into framing. Barrel length to suit sheathing thickness, allowing screw to seat directly against framing with flanged head covering hole in sheathing.
2. Basis of Design: Subject to compliance with requirements, provide the following:
   a. Hohmann & Barnard, Inc.; Thermal 2-Seal Tie, or comparable product by one of the following:
      1) Dur-O-Wal, a Dayton Superior Company.
      2) Heckmann Building Products Inc.
3. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.

E. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 diameter by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Buildex; Teks Maxiseal with Climaseal finish.
   b. Textron Inc., Textron Fastening Systems; Elco Dril-Flex with Stalgard finish.

2.4 STONE TRIM ANCHORS

A. Stone Trim Anchors: Units fabricated with tabs or dowels designed to engage kerfs or holes in stone trim units and holes for fasteners or postinstalled anchor bolts for fastening to substrates or framing as indicated.

1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   a. Halfen Anchoring Systems; Meadow Burke.
   b. Heckmann Building Products Inc.
   c. Hohmann & Barnard, Inc.

B. Materials: Fabricate anchors from stainless steel, ASTM A 240, Type 304. Fabricate dowels from stainless steel, ASTM A 276, Type 304.

C. Fasteners for Stone Trim Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1A1.

2.5 EMBEDDED FLASHING MATERIALS

A. Refer to specification 076210, Flexible Flashing.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or PVC.

B. Weep Hole/Vent Products: Use one of the following unless otherwise indicated:

2. Mesh Weep Holes/Vents: Free-draining mesh; made from polyethylene strands, full width of head joint and 2 inches high by thickness of stone masonry; in color selected from manufacturer's standard.
   a. Products: Subject to compliance with requirements. provide one of the following:
      1) CavClear/Archovations, Inc.; CavClear Weep Vents.
      2) Mortar Net USA, Ltd.; Mortar Net Weep Vents.

C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   1. Provide one of the following configurations:
      a. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.
      b. Strips, not less than 1-1/2 inches thick and 10 inches wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.

2. Products: Subject to compliance with requirements, provide one of the following:
   a. Advanced Building Products Inc.; Mortar Break.
   b. CavClear/Archovations, Inc.; CavClear Masonry Mat.
   c. Dur-O-Wal, a Dayton Superior Company; Polytite MortarStop.
   d. Mortar Net USA, Ltd.; Mortar Net.

2.7 MORTAR MIXES
A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride.
   2. Limit cementitious materials in mortar to portland cement, mortar cement, and lime.
   3. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

   1. Mortar for Setting Stone: Type N.
   2. Mortar for Pointing Stone: Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
   1. Pigments shall not exceed 10 percent of portland cement by weight.
   2. Pigments shall not exceed 5 percent of masonry cement by weight.
   3. Mix to match Architect's sample.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   1. Mix to match Architect's sample.

2.8 FABRICATION
A. Fabricate dressed stone to comply with sizes, shapes, and tolerances recommended by applicable stone association or, if none, by stone source, for faces, edges, beds, and backs.
   1. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."

B. Cut stone to produce pieces of thickness, size, and shape indicated, including details on Drawings. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated.

C. Cut and drill sinkages and holes in stone for anchors and supports.

D. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
   1. Clean sawed backs of stone to remove rust stains and iron particles.

E. Thickness of Stone: Provide thickness indicated, but not less than the following:
   1. Thickness: 4 inches plus or minus 1/4 inch. Thickness does not include projection of pitched faces.

F. Shape stone for type of masonry pattern as follows:
   1. Match existing.

G. Finish exposed faces and edges of stone to comply with requirements indicated for finish and to match approved samples and mockups.
   1. Finish: Match existing.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into stone masonry are correctly installed.
C. Examine wall framing, sheathing, and weather-resistant sheathing paper to verify that stud locations are suitable for spacing of veneer anchors and that installation will result in a weatherproof covering.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Accurately mark stud centerlines on face of weather-resistant sheathing paper before beginning stone installation.
B. Coat concrete and unit masonry backup with asphalt dampproofing.
C. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 SETTING OF STONE MASONRY, GENERAL
A. Perform necessary field cutting and trimming as stone is set.
   1. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.
   2. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
   3. Pitch face at field-split edges as needed to match stones that are not field split.
B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
C. Arrange stones in range ashlar pattern with course heights as indicated, uniform random lengths, and uniform joint widths, with offset between vertical joints as indicated.
D. Arrange stones in broken-range ashlar pattern with uniform course heights, random lengths, and uniform joint widths.
E. Arrange stones in three-course, random-range ashlar pattern with random course heights, random lengths (interrupted coursed), and uniform joint widths.
F. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
G. Set stone to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
H. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 3/8 inch at narrowest points or more than 5/8 inch at widest points.
I. Provide sealant joints of widths and at locations indicated.
   Keep sealant joints free of mortar and other rigid materials. Sealing joints is specified in Division 07 Section "Joint Sealants."
J. Install metal expansion strips in sealant joints at locations indicated. Build flanges of expansion strips into masonry by embedding in mortar between stone masonry and backup wythe. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
K. Install embedded flashing and weep holes at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
   1. At stud-framed walls, extend flashing through stone masonry, up the face of sheathing at least 8 inches, and behind weather-resistant sheathing paper.
   2. At lintels and shelf angles, extend flashing full length of angles but not less than 6 inches into masonry at each end.
   3. At sills, extend flashing not less than 4 inches at ends.
   4. At ends of head and sill flashing turn up not less than 2 inches o form end dams.
   5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
   6. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
7. Extend sheet metal flashing 1/2 inch beyond face of masonry at exterior and turn flashing down to form a drip.
8. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
9. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

Cut flexible flashing flush with face of wall after masonry wall construction is completed.

L. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
1. Use rectangular plastic tubing mesh weep holes/vents to form weep holes.
2. Space weep holes 24 inches o.c.
3. Space weep holes formed from plastic tubing 16 inches o.c.
4. Place pea gravel in cavities as soon as practical to a height of not less than 2 inches above top of flashing, to maintain drainage.
5. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

M. Install vents in vertical head joints at the top of each continuous cavity at spacing indicated. Use rectangular plastic tubing mesh weep holes/vents to form vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.4 CONSTRUCTION TOLERANCES
A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.
B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.
C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet or 3/4 inch in 40 feet or more.
D. Measure variation from level, plumb, and position shown in plan as variation of the average plane of the face of each stone from level, plumb, or dimensioned plane.
E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ANCHORED STONE MASONRY
A. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement by inserting pintles into eyes of masonry joint reinforcement projecting from unit masonry.
B. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement with vertical rods inserted through anchors and through eyes of masonry joint reinforcement projecting from unit masonry.
C. Anchor stone masonry to unit masonry with adjustable, screw-attached veneer anchors unless otherwise indicated. Fasten anchors to unit masonry with two screws.
D. Anchor stone masonry to stud framing with adjustable, screw-attached veneer anchors unless otherwise indicated. Fasten anchors through sheathing to framing with two screws.
E. Anchor stone masonry to stud framing with screw-attached veneer anchors unless otherwise indicated.
F. Anchor stone masonry to wood stud framing with corrugated-metal veneer anchors unless otherwise indicated. Fasten anchors through sheathing to studs with corrosion-resistant roofing nails.
G. Anchor stone masonry to wood stud framing with wire anchors unless otherwise indicated. Fasten anchors through sheathing to wood studs with corrosion-resistant roofing nails.
H. Anchor stone masonry to metal stud framing with wire anchors unless otherwise indicated. Tie anchors to studs.
I. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than 1-1/2 inches, through stone masonry and with at least 5/8-inch cover on outside face.
1. Install continuous wire reinforcement in horizontal joints and attach to seismic veneer anchors as stone is set.
J. Space anchors to provide not less than 1 anchor per 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.
K. Space anchors not more than 16 inches o.c. vertically and 24 inches o.c. horizontally. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.
L. Space anchors not more than 18 inches o.c. vertically and 32 inches o.c. horizontally, with not less than 1 anchor per 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.

M. Anchor stone trim with stone trim anchors where indicated. Install anchors by fastening to substrate and inserting tabs and dowels into kerfs and holes in stone units. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.

N. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.

O. Fill collar joint with mortar as stone is set.

P. Provide 2-inch cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
   1. Place mortar spots in cavity at veneer anchors to maintain spacing.
   2. Slope beds toward cavity to minimize mortar protrusions into cavity.
   3. Do not attempt to trowel or remove mortar fins protruding into cavity.

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

3.6 POINTING
A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch deep until a uniform depth is formed.

B. Point stone joints by placing and compacting pointing mortar in layers not more than 3/8 inch deep. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.

C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
   1. Joint Profile: Match existing.

3.7 ADJUSTING AND CLEANING
A. Remove and replace stone masonry of the following description:
   1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
   2. Defective joints.
   3. Stone masonry not matching approved samples and mockups.
   4. Stone masonry not complying with other requirements indicated.

B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
   3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
   5. Clean limestone masonry to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.8 EXCESS MATERIALS AND WASTE
A. Stone Attic Stock: Five percent of total amount ordered, stack where directed by Owner for Owner's use.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used and other waste, and legally dispose of off Owner's property.

END OF SECTION
SECTION 047200

CAST STONE MASONRY

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Cast stone masonry wall caps as indicated on the Drawings.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
   1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
   1. Include building elevations showing layout of units and locations of joints and anchors.
C. Samples for Initial Selection: For colored mortar.
D. Samples for Verification:
   1. For each color and texture of cast stone required, 10 inches square in size.
   2. For colored mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicated types and amounts of pigments used.

1.4 QUALITY ASSURANCE
A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by the Cast Stone Institute.
B. Source Limitations for Cast Stone: Obtain cast stone units through single source from single manufacturer.
C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.
D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of typical cast stone caps as shown on Drawings.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.
B. Pack, handle, and ship cast stone units in suitable packs or pallets.
   1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.
   2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.
C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
PART 2 - PRODUCTS

2.1 CAST STONE MATERIALS
A. General: Comply with ASTM C 1364.
B. Portland Cement: ASTM C 150, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C 114. Provide natural color or white cement as required to produce cast stone color indicated.
C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C 33; gradation and colors as needed to produce required cast stone textures and colors.
D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C 33, gradation and colors as needed to produce required cast stone textures and colors.
E. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
F. Admixtures: Use only admixtures specified or approved in writing by Architect.
   1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
   2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
   3. Air-Entraining Admixture: ASTM C 260. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
G. Reinforcement: Deformed steel bars complying with ASTM A 615/A 615M, Grade 60. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of cast stone material.
   1. Epoxy Coating: ASTM A 775/A 775M.
   2. Galvanized Coating: ASTM A 767/A 767M.
H. Embedded Anchors and Other Inserts: Fabricated from steel complying with ASTM A 36/A 36M, and hot-dip galvanized to comply with ASTM A 123/A 123M.

2.2 CAST STONE UNITS
A. Provide cast stone units complying with ASTM C 1364 using either the vibrant dry tamp or wet-cast method.
   1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666/C 666M, Procedure A, as modified by ASTM C 1364.
B. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.
   1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
   2. Provide drips on projecting elements unless otherwise indicated.
C. Fabrication Tolerances:
   1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
   2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
   3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
   4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.
D. Cure units as follows:
   1. Cure units in enclosed moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
   2. Keep units damp and continue curing to comply with one of the following:
      a. No fewer than six days at mean daily temperature of 60 deg F or above.
E. Acid etch units after curing to remove cement film from surfaces to be exposed to view.
F. Colors and Textures: As indicated.
2.3 MORTAR MATERIALS
   A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   B. Hydrated Lime: ASTM C 207, Type S.
   C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
   D. Mortar Cement: ASTM C 1329.
   E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.
      1. Products: Subject to compliance with requirements, provide one of the following:
         a. Davis Colors; True Tone Mortar Colors.
         b. Solomon Colors, Inc.; SGS Mortar Colors.
   F. Aggregate for Mortar: ASTM C 144.
      1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
      2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
   G. Water: Potable.

2.4 ACCESSORIES
   A. Anchors: Type and size indicated, fabricated from steel complying with ASTM A 36/A 36M, and hot-dip galvanized to comply with ASTM A 123/A 123M.
   B. Dowels: 1/2-inch diameter, round bars, fabricated from steel complying with ASTM A 36/A 36M, and hot-dip galvanized to comply with ASTM A 123/A 123M.
   C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Diedrich Technologies, Inc.
         b. ProSoCo, Inc.

2.5 MORTAR MIXES
   A. Comply with requirements in Section 042000 "Unit Masonry" for mortar mixes.
   B. Do not use admixtures including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
      1. Do not use calcium chloride in mortar or grout.
      2. Use portland cement-lime or mortar cement mortar unless otherwise indicated.
      1. For setting mortar, use Type N.
      2. For pointing mortar, use Type N.
   D. Pigmented Mortar: Use colored cement produce or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
      1. Pigments shall not exceed 10 percent of portland cement by weight.
      2. Pigments shall not exceed 5 percent of mortar cement by weight.
      3. Mix to match Architect's sample.

2.6 SOURCE QUALITY CONTROL
   A. Engage a qualified independent testing agency to sample and test cast stone units according to ASTM C 1364.
      1. Include one test for resistance to freezing and thawing.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING CAST STONE IN MORTAR
A. Set cast stone as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
   1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
   2. Coordinate installation of cast stone with installation of flashing specified in other Sections.
B. Wet joint surfaces thoroughly before applying mortar or setting in mortar.
C. Set units in full bed of mortar with full head joints unless otherwise indicated.
   1. Set units with joints 3/8 to 1/2 inch wide unless otherwise indicated.
   2. Build anchors and ties into mortar joints as units are set.
   3. Fill dowel holes and anchor slots with mortar.
   4. Fill collar joints solid as units are set.
   5. Build concealed flashing into mortar joints as units are set.
   6. Keep head joints in coping and other units with exposed horizontal surfaces open to receive sealant.
   7. Keep joints at shelf angles open to receive sealant.
D. Rake out joints for pointing with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.
E. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.
F. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
G. Provide sealant joints at copings and other horizontal surfaces, at expansion, control, and pressure-relieving joints, and at locations indicated.
   1. Keep joints free of mortar and other rigid materials.
   2. Build in compressible foam-plastic joint fillers where indicated.
   3. Form joint of width indicated, but not less than 3/8 inch.
   4. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
   5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.3 INSTALLATION TOLERANCES
A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.
D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.
3.4 ADJUSTING AND CLEANING
A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.
B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.
C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone.
   3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
   6. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following:
   1. Structural steel framing members and connections.
   2. Deck support angles.
   3. Shop prime painting and touch up painting in the field.
   4. Temporary construction bracing.
   5. Fabrication and erection inspection and testing.

B. Related Sections include the following:
   1. Division 1 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
   2. Division 1 Section "Submittals" for administrative requirements for the submission of shop drawings and other submittals.
   3. Division 5 Section "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other metal items not defined as structural steel.

1.3 DEFINITIONS
A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

1.4 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 ASD-service loads indicated and comply with other information and restrictions indicated.
   2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.

B. Construction: Type PR, partially restrained.

1.5 SUBMITTALS
A. Submit in accordance with Division 1 Section "Submittals"
B. Submittals for Review

1. Provide complete details and schedules for fabrication and shop assembly of members, erection plans, details, procedures, and diagrams showing sequence of erection of structural steel components.
   a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   b. Include embedment drawings.
   c. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
   d. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.

2. Shop drawings and erection drawings shall not be made by using reproductions of Contract Drawings.

3. Structural steel members for which shop drawings have not been reviewed shall not be fabricated. Engineer's review shall cover general locations, spacings, and details of design. Omission from shop drawings of any materials required by the Contract Documents shall not relieve the Contractor of the responsibility of furnishing and installing such materials, even though such shop drawings may have been reviewed and returned.

C. Submittals for Information:

1. Product Data: For each type of product indicated.
2. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Connection Calculations: Contractor shall design all connections not specifically detailed on the Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Texas. Submit design calculations for the connections designed by the contractor, prior to or with the steel shop drawings. Shop drawings containing connections for which calculations have not been received shall be returned unchecked as an incomplete submittal. Calculations shall be retained for the Engineer's file and will not be approved or returned.
   a. Connections shall be designed in accordance with the requirements specified in the Structural Drawings and Specifications.
   b. Beam connections: Submit a complete calculation for each different beam connection used and detailed on the shop drawings. Conditions which are similar may be grouped together so as to utilize a single connection design.
   c. Submit complete connection calculations for wind brace connections, truss connections, moment connections and other connections where specified on the Contract Drawings. Each calculation shall identify the location or locations for which the connection applies, the member mark(s) from the Contract Documents, the piece mark(s) from the shop drawings, the member size, the design loading(s), member size, and the end of the member to which the connection applies.
   d. The unit of measurement for the connection calculations must follow the United States customary system (USCS).

5. Qualification Data: For installer, fabricator, and testing agency.
6. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
   a. Structural steel including chemical and physical properties.
   b. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   c. Shear stud connectors.
   d. Shop primers.
   e. Nonshrink grout.

7. Source quality-control test reports.
1.6 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.

B. Fabricator Qualifications: Company specializing in performing the work of this section with minimum 10 years of documented experience.

C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

D. The latest adopted edition of all standards referenced in this Section shall apply unless noted otherwise. In case of conflict between these Contract Documents and the referenced standard, the Contract Documents shall govern. In case of conflict between these Contract Documents and the Building Code, the more stringent shall govern.

E. The Contractor shall furnish fabrication and erection inspection and testing of all welds in accordance with AWS D1.1, Chapter 6. Submit records of inspections and tests to the Owner's testing laboratory for their review. The fabrication and erection inspectors shall be AWS certified welding inspectors.

F. All materials, fabrication procedures and field erection are subject to verification inspection and testing by the Owner's testing laboratory in both the shop and field. Such inspections and tests will not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with specified requirements.

G. Qualifications for Welding Work: Contractor shall be responsible for qualifying welding operators in accordance with the AWS "Standard Qualification Procedure." Provide certification to Owner's testing laboratory that welders to be employed in the work have satisfactorily passed AWS qualification tests. Recertification of welders shall be Contractor's responsibility.

H. Qualification of Welding Procedures: Contractor shall provide the testing laboratory with welding procedures which are to be used. Welding procedures shall be qualified prior to use in accordance with AWS D1.1, Part B.

I. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges"
2. AISC's "Specification for Structural Steel Buildings."
3. ASTM A6 "Specifications for General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
5. RCSC's "Specification for Structural Joints Using High Strength Bolts."
6. AWS D1.1 "Structural Welding Code"
7. SSPC (Society for Protective Coatings), standards as noted.

J. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

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

1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
2. 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.
1.8 COORDINATION

A. Furnish 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.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992.
B. Channels, Angles: ASTM A 36.
C. Plate and Bar: ASTM A 36.
D. Corrosion-Resisting Structural Steel: ASTM A 588/A 588M, Grade 50.
E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
F. Corrosion-Resisting Cold-Formed Hollow Structural Sections: ASTM A 847, structural tubing.
G. Steel Pipe: ASTM A 53, Type E, Grade B.
   1. Weight Class: As indicated.
   2. Finish: Black, except where indicated to be galvanized.
H. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM F3125, grade A 325, Type 1 [Type 3 at corrosion-resisting (weathering) steel], heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
   1. Finish: Plain. [None at corrosion-resisting (weathering) steel].
B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
C. Unheaded Anchor Rods: ASTM F 1554, Grade 36.
   5. Finish: Plain.
   3. Finish: Plain.
E. Adhesive Anchors:
   1. In concrete:
a. HIT RE 500V3-Safe Set System, Hilti Inc.
b. SET-XP epoxy, Simpson Strong-Tie, Inc.
c. HIT-HY 200 Safe Set System, Hilti, Inc.
d. AT-XP acrylic, Simpson Strong-Tie Company, Inc.
2. In grouted concrete masonry:
   a. HIT-HY 70, Hilti, Inc.
   b. SET epoxy, Simpson Strong-Tie Company, Inc.
   c. AT-XP acrylic, Simpson Strong-Tie Company, Inc.
3. In ungrouted concrete masonry:
   a. HIT-HY 70, Hilti, Inc.
   b. SET epoxy, Simpson Strong-Tie Company, Inc.
4. Adhesive anchor rods: As noted on the drawings.

2.3 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, Grade B, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time, capable of developing a minimum compressive strength of 5,000 psi at 28 days.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges", AISC's "Specification for Structural Steel Buildings", and as indicated on accepted shop drawings.

1. Camber structural-steel members where indicated.
2. Mill tolerances shall conform to ASTM A6. 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. Plates shall be free of gross discontinuities such as ruptures and delaminations. Plates shall comply with ASTM A578, Level 1.
5. 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.

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. Members in compression joints which depend on contact bearing shall have the bearing surfaces milled to a common plane. Members to be milled shall be completely assembled before milling.

E. Base Plates: Oversize anchor bolt holes in base plates to facilitate erection as specified in Table 14-2 in AISC 360-10.

F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning, SSPC-SP 2, "Hand Tool Cleaning, or SSPC-SP 3, "Power Tool Cleaning."
G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer’s written instructions.

H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC’s “Specification for Structural Joints Using ASTM F3125, grade A 325 or grade A 490 Bolts” for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.
2. Provide washers over all slotted holes in an outer ply.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. Welds not specified shall be continuous fillet welds designed to develop the full strength of the member. A combination of welds and bolts shall not be used to transmit stress at the same face of any connections. Clean completed welds prior to inspection. Slag shall be removed from all completed welds.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
5. Surfaces of exposed high strength, low alloy steel members (weathering steel).
6. Top surfaces of beams which support composite metal floor deck.
7. Headed shear studs, although overspray is acceptable.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, “Hand Tool Cleaning.”
2. SSPC-SP 3, “Power Tool Cleaning.”

C. Priming: Immediately after surface preparation, apply primer according to manufacturer’s written instructions and rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.

1. Fill vent holes and grind smooth after galvanizing.

B. Galvanizing: The following steel shall be hot-dip galvanized (including any associated fasteners):

1.Lintels and shelf angles attached to structural-steel frame and located in exterior walls.
2. Railing exposed to weather.

2.9 SOURCE QUALITY CONTROL

A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM F3125, grade A 325 or grade A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
4. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:

1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

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

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Design of temporary bracing and supports shall be the responsibility of the Contractor. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC’s “Code of Standard Practice for Steel Buildings and Bridges” and “Specification for Structural Steel Buildings—Allowable Stress Design and Plastic Design,” unless closer tolerances are required for proper fitting of adjoining or enclosing materials, in which case the more stringent shall apply.

B. Maintain erection tolerances of structural steel within AISC’s “Code of Standard Practice for Steel Buildings and Bridges,” Unless adjoining materials dictate a tighter tolerance.

C. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

D. Splice members only where indicated. Any member having a splice not shown and detailed on the accepted shop drawings shall be rejected.

E. Do not field cut or alter structural members without approval of Architect/Engineer. Do not use thermal cutting during erection unless approved by Architect/Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.

F. Gas Cutting: Do not use gas cutting torches in the field to correct fabrication errors in structural framing.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC’s “Specification for Structural Joints Using ASTM F3125, grade A 325 or grade A 490 Bolts” for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

2. A307 bolts and high-strength (ASTM F3125, grade A325 and grade A490) bolts noted to be “snug-tight” shall be tightened using a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench, bringing the plies into contact.

3. High-strength bolts which are not specifically designated to be "snug-tight" shall be tightened to provide at least the minimum tension shown in Table 4 of the "Specification for Structural Joints using ASTM F3125, grade A325 and grade A490 Bolts." Tightening shall be done by the turn-of-the-nut method, with direct tension indicators, or by properly calibrated wrenches.

4. Bolts tightened with a calibrated wrench or by torque control shall have a hardened washer under the element (nut or bolt head) turned in tightening.
5. Hardened washers shall be placed over slotted holes in an outer ply. Hardened beveled washers shall be used where the outer face of the bolted parts has a slope greater than 1:20 with respect to the bolt axis.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. Welds not specified shall be continuous fillet welds designed to develop the full strength of the member. A combination of welds and bolts shall not be used to transmit stress at the same face of any connections. Clean completed welds prior to inspection. Slag shall be removed from all completed welds.


3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM F3125, grade A 325 or grade A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   c. Ultrasonic Inspection: ASTM E 164.
   d. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touch-up Cold Galvanizing: Touch up areas of hot dip galvanized members where galvanizing has been abraded during shipping and erection and areas where galvanizing has been removed or damaged due to welding. Apply cold galvanizing compound in accordance with the manufacturer's instructions to a minimum dry film thickness of 2.0 mils.

END OF SECTION 051200
SECTION 051213

ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

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 architecturally exposed structural-steel (AESS) framing and components as indicated on the Drawings.
1. Requirements in Division 05 Section "Structural Steel Framing" also apply to AESS framing.

1.3 DEFINITIONS
A. Architecturally Exposed Structural Steel: Structural steel designated as "architecturally exposed structural steel" or "AESS" in the Contract Documents.
B. Category 1 AESS: AESS that is within 96 inches vertically and 36 inches horizontally of a walking surface and is visible to a person standing on that walking surface or is designated as "Category 1 architecturally exposed structural steel" or "AESS-1" in the Contract Documents.
C. Category 2 AESS: AESS that is within 20 feet vertically and horizontally of a walking surface and is visible to a person standing on that walking surface or is designated as "Category 2 architecturally exposed structural steel" or "AESS-2" in the Contract Documents.
D. Category 3 AESS: AESS above 20 feet (6 m) vertically and horizontally of a walking surface and is visible to a person standing on that walking surface.

1.4 SUBMITTALS
A. Shop Drawings: Show fabrication of AESS components. Shop Drawings for structural steel may be used for AESS provided items of AESS are specifically identified and requirements below are met for AESS.
1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. Indicate grinding, finish, and profile of welds.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
5. Indicate exposed surfaces and edges and surface preparation being used.
6. Indicate special tolerances and erection requirements.
B. Mock-ups: Provide mock-ups of small sections of AESS applications, showing quality of welding and finishing operations to be expected on the actual in-place construction.

1.5 QUALITY ASSURANCE
A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
B. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

1.6 DELIVERY, STORAGE, AND HANDLING
A. Use special care in handling to prevent twisting, warping, nicking, and other damage. 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.

1.7 PROJECT CONDITIONS
A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.
1.8 COORDINATION
A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

PART 2 - PRODUCTS

2.1 BOLTS, CONNECTORS, AND ANCHORS
A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round-head assemblies, consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Finish: Plain.

2.2 PRIMER
A. Primer: SSPC-Paint 25 BCS, Type II, zinc oxide.
B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
C. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.
D. Shop Primer for Galvanized Steel: Water-based galvanized metal primer complying with MPI#134, color: gray.

2.3 FABRICATION
A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.
B. In addition to special care used to handle and fabricate AESS, comply with the following:
   1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
   2. Grind sheared, punched, and flame-cut edges of Category 1 AESS to remove burrs and provide smooth surfaces and edges.
   3. Fabricate Category 1 AESS with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
   4. Fabricate Category 1 and Category 2 AESS with exposed surfaces free of seams to maximum extent possible.
   5. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
   6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
   7. Fabricate Category 1 AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
   8. Fabricate Category 2 and Category 3 AESS to the tolerances specified in AISC 303 for steel that is not designated AESS.
   9. Seal-weld open ends of hollow structural sections with 3/8-inch closure plates for Category 1 AESS.
C. Curved Members: Fabricate indicated members to curved shape by rolling to final shape in fabrication shop.
   1. Distortion of webs, stems, outstanding flanges, and legs of angles shall not be visible from a distance of 20 feet 6 m under any lighting conditions.
   2. Tolerances for walls of hollow steel sections after rolling shall be approximately 1/2 inch.
D. Coping, Blocking, and Joint Gaps: Maintain uniform gaps of 1/8 inch with a tolerance of 1/32 inch for Category 1 AESS.
E. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.4 SHOP CONNECTIONS
A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work, and comply with the following:
   1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding specified tolerances.
   2. Use weld sizes, fabrication sequence, and equipment for AESS that limit distortions to allowable tolerances.
   3. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AESS is exposed to weather.
   4. Provide continuous welds of uniform size and profile where AESS is welded.
   5. Make butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch for Category 1 and Category 2 AESS. Do not grind unless required for clearances or for fitting other components, or unless directed to correct unacceptable work.
   6. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for Category 1 and Category 2 AESS.
   7. At locations where welding on the far side of an exposed connection of Category 1 and Category 2 AESS occurs, grind distortions and marking of the steel to a smooth profile aligned with adjacent material.
   8. Make fillet welds for Category 1 and Category 2 AESS of uniform size and profile with exposed face smooth and slightly concave. Do not grind unless directed to correct unacceptable work.

2.5 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.
   1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
   2. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

2.6 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   3. Surfaces to be high-strength bolted with slip-critical connections.
   4. Surfaces to receive sprayed fire-resistive materials.
   5. Galvanized surfaces.

B. Surface Preparation for Non-galvanized Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."

C. Preparing Galvanized Steel for Shop Priming: After galvanizing, thoroughly clean steel of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

D. 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. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
   1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION
   A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS 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.
   1. If possible, locate welded tabs for attaching temporary bracing and safety cabling where they will be concealed from view in the completed Work.
   2. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION
   A. Set AESS accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
   1. Erect Category 1 AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
   2. Erect Category 2 and Category 3 AESS to the tolerances specified in AISC 303 for steel that is not designated AESS.
   B. Do not use thermal cutting during erection.

3.4 FIELD CONNECTIONS
   A. High-Strength Bolts: Install high-strength bolts according to RCSC’s "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.
   2. Orient bolt heads all in same direction.
   1. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for Category 1 and Category 2 AESS.
   2. Remove erection bolts in Category 1 and Category 2 AESS, fill holes, and grind smooth.
   3. Fill weld access holes in Category 1 and Category 2 AESS and grind smooth.

3.5 FIELD QUALITY CONTROL
   A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect AESS as specified in Division 05 Section "Structural Steel Framing." The testing agency will not be responsible for enforcing requirements relating to aesthetic effect.
   B. Architect will observe AESS in place to determine acceptability relating to aesthetic effect.

3.6 REPAIRS AND PROTECTION
   A. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Grind steel smooth.
   B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
   C. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas 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.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Furnish all labor and materials required to fabricate, deliver, and erect steel joists and joist girders, including all bridging, ceiling extensions, bearing plates, side wall anchors, and extended ends.

B. This Section includes the following:
   2. KCS-type K-series steel joists.

1.3 DEFINITIONS

A. SJI "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.

B. Design special joists to withstand design loads with live load deflections no greater than the following:
   1. Roof Joists: Vertical deflection of 1/360 of the span.

1.5 SUBMITTALS

A. Submit in accordance with Division 1 Section “Submittals.”

B. Submittals for Review:
   1. Shop Drawings: Show layout, designation, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, camber, coatings, material properties, configuration, joist accessories; splice and connection locations and details; and attachments to other construction.

C. Submittals for Information:
   1. Design calculations for all joists for which the standard load tables are not applicable. Submit prior to, or with the shop drawings. Calculations shall bear the seal of a Registered Professional Engineer,
licensed in the State of Texas. Shop drawings submitted without corresponding calculations will be returned unchecked as an incomplete submittal. Calculations will be retained for the Architect's file and will not be approved or returned.

2. Welders Certificates: Submit certificates to Owner's Testing Laboratory, certifying that welders to be employed on the project have passed AWS qualification tests within the previous 12 months. If recertification of welders is required, recertification shall be contractor's responsibility.

3. Product Data: For each type of joist, accessory, and product indicated.
   a. Indicate locations and details of bearing plates to be embedded in other construction.

4. Manufacturer Certificates: Signed by manufacturers certifying that joists comply with requirements.

5. Mill Certificates: Signed by bolt manufacturers certifying that bolts comply with requirements.

6. Field quality-control test and inspection reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists, including headers and other supplemental framing, complying with applicable standard specifications and load tables of SJI "Specifications." Manufacturer shall have a minimum of five years documented experience in the design and fabrication of open-web joists and joist girders

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. SJI Specifications: Comply with standard specifications in SJI's "Specifications" that are applicable to types of joists indicated.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel: Comply with SJI's "Specifications" for web and steel-angle chord members.

B. Structural Steel For Supplementary Framing and Joist Leg Extensions: ASTM A36, minimum

C. Steel Bearing Plates: ASTM A36/A 36M.

D. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A, carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.7

1. Finish: Plain, uncoated.
E. High-Strength Bolts, Nuts, and Washers: ASTM F3125, grade A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Plain.

F. Welding Electrodes: Comply with AWS standards.

2.2 PRIMERS

A. Primer: SSPC-Paint 15, Type 1 red oxide, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.3 K-SERIES STEEL JOISTS


B. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work. Refer to Section 2.7 C. for additional welding requirements.

C. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."

D. Camber joists according to SJI's "Specifications." Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.4 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.

B. Fabricate steel bearing plates with integral anchorages of sizes and thicknesses indicated. Shop prime paint.

C. Supply ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch of finished wall surface, unless otherwise indicated.

D. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

2.5 FABRICATION

A. Splices: Shop splices may occur in chord or web members. Members containing a butt weld splice shall develop an ultimate tensile force of at least 57,000 psi times the full design area of the chord or web.

B. Holes shall not be made or enlarged by burning with a torch.

C. Welds shall meet the following criteria for acceptance:
1. Remove slag from welds prior to inspection.
2. Cracked welds are not acceptable and must be repaired.
3. Thorough fusion shall exist between the weld and base metal, as determined by visual inspection.
4. Unfilled weld craters shall not be included in the design length of the weld.
5. Undercut shall not exceed 1/16" provided that it is oriented parallel to the principal stress.
6. The sum of surface (piping) porosity diameters shall not exceed 1/16" in any 1" of design weld length.
7. Weld spatter that does not interfere with paint coverage is acceptable.

2.6 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Apply 1 coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Minimum bearings and anchorage shall conform to referenced SJI standards and the Drawings.
4. Allow for erection loads. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction. Construction loads shall not be applied until joists are permanently fastened to supports and all bridging has been installed.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using ASTM A 307 carbon-steel bolts.

E. Bridging shall conform to SJI standards and the shop drawings. Provide and install extra bridging, where indicated or where required due to loading, in addition to the minimum SJI requirements. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.
3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

B. Field welds will be visually inspected according to AWS D1.1/D1.1M.

C. In addition to visual inspection, field welds will be tested according to AWS D1.1/D1.1M and the following procedures, as applicable:
   4. Liquid Penetrant Inspection: ASTM E 165.

D. Bolted connections will be visually inspected.

E. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC’s “Specification for Structural Joints Using ASTM F3125, grade A 325 or grade ASTM A 490 Bolts.”

F. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.

G. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

3.4 REPAIRS AND PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION 052100
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Roof deck.

B. Work Included

1. Furnish all labor and materials required to fabricate, deliver and install steel roof deck and accessories including formed steel cant strips, eave strips, valley strips, sump pans, edge closures, pour stops, reinforcing plates and related accessories.
2. Furnish all labor and materials required to fabricate, deliver and install steel floor deck and accessories including formed steel end closures, edge forms, flashings, and reinforcing plates, headed shear studs, and related accessories.

C. Related Sections include the following:
1. Division 5 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
2. Product Data: For each type of deck, accessory, and product indicated. Provide deck dimensions, sectional properties, uplift resistance and diaphragm capacity for specified fastener layout and support spacing, and finishes.

B. Submittals for Information:

1. Product Certificates: For each type of steel deck, signed by product manufacturer. Certify that products comply with SDI, UL and ICC standards as specified.
2. Manufacturer’s installation instructions.
3. Welding certificates: For each welder employed on the Work.
4. Field quality-control test and inspection reports.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
   a. Power-actuated mechanical fasteners.
6. ICC Evaluation Service Reports: Deck units shall be approved by the International Code Council and shall have a corresponding report from ICC.
1.4 QUALITY ASSURANCE

A. Installer: Company specializing in performing the work of this Section with minimum 5 years documented experience.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.

C. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

D. Comply with applicable provisions of the following specifications and documents.

1. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
2. SDI (Steel Deck Institute) - Design Manual for Composite Decks, Form Decks, Roof Decks.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steel Deck:
   b. Consolidated Systems, Inc.
   c. Epic Metals Corporation.
   d. New Millennium Building Systems, LLC.
   e. Nucor Corp.; Vulcraft Division.
   f. Verco Manufacturing Co.

2.2 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

1. Galvanized Steel Sheet: ASTM A 653/A, Structural Steel (SS), Grade 33, G60 zinc coating.
2. Deck Profile: As indicated.
3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: As indicated.
2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
   1. Mechanical Fasteners: Galvanized hardened steel, self-tapping "Teks" screws, manufactured by Illinois Tool Works, Inc., Buildex Division, or equal. Size shall be #10 minimum, unless noted otherwise.
   2. Powder Actuated Fasteners: Zinc coated fastener with .145 inch shank diameter and 1 1/4 inch shank length. X-DNI pin as manufacturer by Hilti, or equal.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

G. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, sealed watertight. For drains, cut holes in the field.

H. Galvanizing Repair Paint: ASTM A780.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.

B. Locate deck bundles to prevent overloading of supporting members.

C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

H. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer’s written instructions.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
   1. Weld Diameter: As indicated.
   2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches, and as follows:
   1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
   2. Mechanically clinch or button punch.
   3. Fasten with a minimum of 1-1/2-inch-long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
   1. End Joints: Lapped 2 inches minimum.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer’s written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
   1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer’s written instructions to ensure complete closure.

F. Architectural finishes and mechanical, electrical, and plumbing equipment shall not be hung directly from the metal deck.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor’s expense, will be performed to determine compliance of corrected work with specified requirements.
3.5 REPAIRS AND PROTECTION

   A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

   B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 053100
SECTION 05400
COLD-FORMED METAL FRAMING

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 non-load-bearing wall framing.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of cold-formed steel framing product and accessory.
B. Shop Drawings:
1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.5 QUALITY ASSURANCE
A. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
B. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

1.6 DELIVERY, STORAGE, AND HANDLING
A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Dietrich Metal Framing; a Worthington Industries Company.
2. MarinoWARE.
3. Nuconsteel; a Nucor Company.
4. Steel Network, Inc. (The).

2.2 PERFORMANCE REQUIREMENTS
A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
1. Design Loads: As indicated.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
   a. Exterior Non-Load-Bearing Framing: 1/600 of the wall height, supporting masonry veneer.
3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
   a. Upward and downward movement of 3/4 inch or as otherwise indicated on the structural drawings.

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Design Standards:
   1. Wall Studs: AISI S211.

D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
   1. Grade: As required by structural performance
   2. Coating: G60 typical and G90 in coastal areas

B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
   1. Grade: As required by structural performance.
   2. Coating: G60 typical.

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0538 inch.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0538 inch.

C. Vertical Deflection Clips: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ClarkWestern Building Systems, Inc.
      b. Dietrich Metal Framing; a Worthington Industries company.
      c. MarinoWARE.
      d. Steel Network, Inc. (The).
   2. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
      1. Minimum Base-Metal Thickness: 0.0538 inch.
      2. Flange Width: 1 inch plus twice the design gap for other applications.

2.5 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
9. Joist hangers and end closures.

2.6 ANCHORS, CLIPS, AND FASTENERS
A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by mechanically deposition according to ASTM B 695, Class 50.
C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
   1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
F. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS
A. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B.
B. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.
C. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.8 FABRICATION
A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   1. Fabricate framing assemblies using jigs or templates.
   2. Cut framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
   4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squaresness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.
3.1 EXAMINATION
   A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Install load bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
   B. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL
   A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
   B. Install cold-formed steel framing according to AISI S200 and to manufacturer’s written instructions unless more stringent requirements are indicated.
   C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
      1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
   D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
      1. Cut framing members by sawing or shearing; do not torch cut.
      2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
         a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
         b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
   E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
   F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
   G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
   H. Install insulation, specified in Section 072100 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
   I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer’s approved or standard punched openings.
   J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
      1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION
   A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
   B. Fasten both flanges of studs to bottom track unless otherwise indicated. Space studs as follows:
      1. Stud Spacing: As required by design, but not less than 18 inches.
   C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
   D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
      1. Install single deep-leg deflection tracks and anchor to building structure.
      2. Connect vertical deflection clips to studs and anchor to building structure.
E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
   1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
   2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
   3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 FIELD QUALITY CONTROL
A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
B. Field and shop welds will be subject to testing and inspecting.
C. Testing agency will report test results promptly and in writing to Contractor and Architect.
D. Remove and replace work where test results indicate that it does not comply with specified requirements.
E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION
A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000
SECTION 055000
METAL FABRICATIONS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Steel framing and supports for countertops.
2. Steel tube reinforcement for butt-glazed partitions.
3. Steel framing and supports for mechanical and electrical equipment.
4. Steel framing and supports for applications where framing and supports are not specified in other Sections.
5. Shelf angle and lintels for masonry construction.
6. Metal ladders.
7. Ladder safety cages.
8. Metal bollards.
10. Loose bearing and leveling plates for applications where they are not specified in other Sections.
B. Products furnished, but not installed, under this Section include the following:
1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

1.3 COORDINATION
A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS
A. Product Data: For the following:
1. Metal ladders.
2. Ladder safety cages.
3. Metal bollards.
4. Nonslip aggregates and nonslip-aggregate surface finishes.
5. Paint products.
B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
1. Shelf angles.
2. Steel framing and supports for operable partitions.
3. Steel framing and supports for countertops.
4. Steel framing and supports for operable panel partitions.
5. Steel tube reinforcement for butt-glazed partitions.
6. Metal ladders.
7. Ladder safety cages.
8. Steel framing and supports for mechanical and electrical equipment.
9. Steel framing and supports for applications where framing and supports are not specified in other Sections.
10. Shelf angles.
11. Lintels
12. Metal bollards.
C. Delegated-Design Submittal: For ladders and ladder safety cages, including analysis data signed and 
sealed by the qualified professional engineer responsible for their preparation.

D. Qualification Data: For professional engineer's experience with providing delegated-design engineering 
services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which 
Project is located.

E. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with 
requirements.

F. Welding certificates.

G. Welding certificates.

H. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that 
shop primers are compatible with topcoats.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal 
fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 “Quality 
Requirements,” to design ladders and safety cages.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting 
on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, 
failure of connections, and other detrimental effects.

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

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For 
metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller 
marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-
plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior 
walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563;
and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, 
Grade C3; and, where indicated, flat washers.

D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where 
indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is 
indicated to be galvanized.

E. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load 
imposed when installed in unit masonry and four times the load imposed when installed in concrete, as 
determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing 
agency.

F. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 
or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-
steel bolts, ASTM F 593, and nuts, ASTM F 594.

G. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with 
MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at 
not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and 
nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.
2.4 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat specified in Section 099000

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated.

C. Fabricate supports for operable partitions from continuous steel beams of sizes recommended by partition manufacturer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Galvanize miscellaneous framing and supports where indicated.

E. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 SHELF ANGLES AND LINTELS

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
   1. Provide mitered and welded units at corners.
   2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. Galvanize and prime shelf angles located in exterior walls.

C. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.
2.8 METAL LADDERS

A. General:
   1. Comply with ANSI A14.3.

B. Steel Ladders:
   1. Space siderails 18 inches apart unless otherwise indicated.
   4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
   5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
   6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Harsco Industrial IKG, a division of Harsco Corporation.
         2) W.S. Molnar Company.
      b. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.

2.9 LADDER SAFETY CAGES

A. General:
   1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless steel fasteners.
   2. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.
   3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless steel fasteners unless otherwise indicated.

B. Steel Ladder Safety Cages:
   1. Primary Hoops: 1/4-by-4-inch flat bar hoops.
   3. Vertical Bars: 3/16-by-1-1/2-inch flat bars secured to each hoop.
   4. Galvanize and prime ladder safety cages, including brackets and fasteners.

2.10 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

D. Prime in accordance with requirements of Section 099100.

2.11 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe.
   1. Cap bollards with 1/4-inch-thick steel plate.
   2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
   3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Prime bollards in accordance with requirements of Section 099100.

2.12 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.
2.13 DUMPSTER ENCLOSURE GATES
   A. Provide shop fabricated gate frames of structural steel plates, angles, tubes and shapes indicated on the drawings complete with hinges, cane bolts, latch and pad-locking provisions, with structural metal deck cladding panels as indicated on the drawings.
   B. Prime dumpster gate frames and panels in accordance with requirements of Section 099100.

2.14 LOOSE BEARING AND LEVELING PLATES
   A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
   B. Galvanize plates.
   C. Prime plates with requirements of Section 099100, zinc-rich primer.

2.15 FINISHES, GENERAL
   A. Finish metal fabrications after assembly.
   B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.16 STEEL AND IRON FINISHES
   A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
      1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
   B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, or masonry, or unless otherwise indicated.
      1. Shop prime with universal shop primer zinc-rich primer is primer as indicated in Section 091000

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL
   A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
   B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
   C. Field Welding: Comply with the following requirements:
      1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
      2. Obtain fusion without undercut or overlap.
      3. Remove welding flux immediately.
      4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
   D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
   E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS
   A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
   B. Anchor supports for folding partitions securely to, and rigidly brace from, building structure.

3.3 INSTALLING BEARING AND LEVELING PLATES
B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLATION OF METAL BOLLARDS
A. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

3.5 ADJUSTING AND CLEANING
A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099100.

END OF SECTION
SECTION 055100
WEATHERING STEEL

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. Weathering steel plates and trim at internally illuminated monumental sign.
B. Related Requirements:
   1. Section 033000 "Cast in Place Concrete" for concrete monumental sign foundations.
   2. Section 044200 "Dimension Stone Cladding".

1.3 COORDINATION
A. Coordinate installation of anchorages for weathering steel. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

1.4 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product, including finishing materials.
B. Shop Drawings: Show fabrication and installation details for weathering steel.
   1. Include plans, elevations, component details, and attachment details.
   2. Indicate materials and profiles of each weathering steel member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
C. Samples for Verification: For each type of exposed finish required, prepared on 6-inch-square Samples of metal of same thickness and material indicated for the Work.

1.6 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: For weathering steel elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.
B. Qualification Data: For installer and fabricator.
C. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.7 QUALITY ASSURANCE
A. Fabricator Qualifications: A firm experienced in producing weathering steel similar to that indicated for this Project and with a record of successful in-service performance as well as sufficient production capacity to produce required units.
B. Installer Qualifications: Fabricator of products.
C. Mockups: Build mockup to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Subject to compliance with requirements, approved mockup may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Deliver weathering steel products wrapped in protective coverings and strapped together in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.
B. Store products on elevated platforms in a dry location.
FIELD CONDITIONS
A. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with weathering steel by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Structural Performance: Weathering steel items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:
  1. Wind Loads on Exterior Items: As indicated on Drawings.
B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, over stressing of components, failure of connections, and other detrimental effects.
  1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 WEATHERING STEEL
A. High-strength low-alloy structural steel shapes, plates, and bars for welded, riveted, or bolted construction as indicated of weathering steel plates, shapes and bar stock per ASTM A588, “Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi Minimum Yield Point, with Improved Atmospheric Corrosion Resistance”.
B. Fabricate products from weathering steel plates and shapes as indicated without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.
  1. welding procedure suitable for the grade of steel and intended use or service is to be utilized, per Appendix X3 of Specification A6 “Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling” for information on weldability.
  2. Size and thickness: As indicated or as required by design.
C. Manufacturers: Subject to compliance with specifications provide products by one of the following:
  1. Central Steel Service, Inc., 2764 Welborn St., Pelham, AL 35124 (205.664.2950).
  2. Leeco Steel, 1011 Warrenville Rd, Ste. 500 Lisle, IL 60532 (630.427.2100).
  3. Corten Structural Companies, Western States Metal Roofing, 901 W. Watkins St., Phoenix, AZ 85007 (855-426-7836).
D. Substitutions in accordance with Division 1 section 012500 “Substitution Procedures.”

2.3 MISCELLANEOUS MATERIALS
A. Sealants, Exterior: Elastomeric sealant complying with Section 079200 "Joint Sealants" and as recommended in writing by weathering steel manufacturer.
B. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as necessary for strength, corrosion resistance, and compatibility in fabricated items.
  1. Use filler metals that will match the color of metal being joined and will not cause discoloration.
C. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.
  1. Provide concealed fasteners for interconnecting weathering steel and for attaching them to other work unless exposed fasteners are unavoidable or are the standard fastening method.
  2. Provide Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.
D. Structural Anchors: For applications indicated to comply with design loads, provide fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
E. Nonstructural Anchors: For applications not indicated to comply with design loads, provide fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
F. Anchor Materials:

2.4 FABRICATION, GENERAL
A. Shop Assembly: Preassemble weathering steel items in shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
B. Coordinate dimensions and attachment methods for weathering steel with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.
   1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining plates in flush alignment.

D. Build in plates, and brackets as needed to support and anchor fabricated items to adjoining construction.
   Reinforce weathering steel as needed to attach and support other construction.

E. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install weathering steel.

F. Where welding is indicated, weld joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.
   1. Use welding and brazing procedures that will blend with and not cause discoloration of metal being joined.

2.5 GENERAL FINISH REQUIREMENTS

A. Complete mechanical finishes of flat plate metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match plate finish.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.

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

3.2 INSTALLATION

A. Locate and place weathering steel level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.
   1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior weathering steel lightproof as applicable to type of fabrication indicated.

E. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

3.3 ADJUSTING AND CLEANING

A. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinshed in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes of weathering steel from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION

WEATHERING STEEL
05S100 - 3
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. Beam wraps, fascias and trim.

1.3 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design exterior decorative formed metal items, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Structural Performance: Decorative formed metal items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:
C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated. Include finishing materials.
B. Shop Drawings: Show fabrication and installation details for decorative formed metal.
   1. Include plans, elevations, component details, and attachments to other work.
   2. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
C. Samples: For each type of exposed finish required, prepared on 12-inch-square Samples of metal of same thickness and material indicated for the Work.
D. Qualification Data: For qualified fabricator professional engineer.

1.5 QUALITY ASSURANCE
A. Fabricator Qualifications: A firm experienced in producing decorative formed metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
B. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code - Steel."
C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups for the following types of decorative formed metal:
      a. Custom perforated shade panel.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver custom perforated shade panels wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.
B. Store products on elevated platforms in a dry location.
1.7 PROJECT CONDITIONS
A. Field Measurements: Verify actual locations of walls, supports, beams, and other construction contiguous with custom perforated shade panels by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION
A. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
B. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes.

PART 2 - PRODUCTS

2.1 SHEET METAL
A. General: Provide sheet metal without pitting, seam marks, roller marks or other imperfections where exposed to view on finished units.
B. Aluminum Sheet: Flat sheet complying with ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H32.

2.2 MISCELLANEOUS MATERIALS
A. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items.
1. Use filler metals that will match the color of metal being joined and will not cause discoloration.
B. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.
1. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless otherwise indicated.
2. Provide Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.
C. Structural Anchors: For applications indicated to comply with certain design loads, provide torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
D. Anchor Materials:

2.3 FABRICATION, GENERAL
A. Shop Assembly: Pre-assemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.
B. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.
C. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch- wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch and support with concealed stiffeners.
D. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.
1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
E. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.
F. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.

G. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.
   1. Use welding and brazing procedures that will blend with and not cause discoloration of metal being joined.

2.4 BEAM WRAPS, TRIM, BRAKE METAL FASCIAS
A. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction, with weathertight joints at exterior installations.
   1. Aluminum Sheet: 0.063 inch.
   2. Closures and trim may be fabricated from prefinished metal sheet in lieu of finishing after fabrication. Provide unfinished edges that are concealed from view and not exposed to weather.
B. Conceal fasteners where possible; otherwise, locate where they are as inconspicuous as possible. Size fasteners to support closures and trim, with fasteners spaced to prevent buckling or waviness in finished surfaces.
C. Drill and tap holes needed for securing closures and trim to other surfaces.
D. Incorporate gaskets where indicated or needed for concealed, continuous seal at abutting surfaces.
E. Miter or cope trim members at corners and reinforce with bent metal splice plates to form tight joints.

2.5 GENERAL FINISH REQUIREMENTS
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.
C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.6 ALUMINUM FINISHES
A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   1. Color and Gloss: Refer to Drawings.

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 decorative formed metal.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Locate and place custom perforated shade panels level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.
   1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.
C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

3.3 ADJUSTING AND CLEANING
A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.
B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.
3.4 PROTECTION
   A. Protect finishes of decorative formed metal items from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

   END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Wood blocking and nailers.
   2. Utility shelving.
   3. Plywood backing panels.

1.3 DEFINITIONS
A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   3. NLGA: National Lumber Grades Authority.
   5. WCLIB: West Coast Lumber Inspection Bureau.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
   4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL
A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the 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, mark grade stamp on end or back of each piece.
   3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   4. Provide dressed lumber, S4S, unless otherwise indicated.
B. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS
A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
D. Application: Treat items indicated on Drawings, and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
   3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.

2.3 FIRE-RETARDANT-TREATED MATERIALS
A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Use treatment that does not promote corrosion of metal fasteners.
   2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
   3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
   4. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841]
C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
F. Application: Treat all miscellaneous carpentry unless otherwise indicated.
   1. Concealed blocking.
2. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER
A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.
1. Mixed southern pine; SPIB.
C. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
1. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
D. 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.
E. 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.

2.5 PLYWOOD BACKING PANELS
A. Equipment Backing Panels: DOC PS 1, Exterior, AC, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS
A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.
B. Nails, Brads, and Staples: ASTM F 1667.
D. Wood Screws: ASME B18.6.1.
E. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.
F. Lag Bolts: ASME B18.2.1.
G. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL
A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
B. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
C. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
E. Do not splice structural members between supports unless otherwise indicated.
F. 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 o.c.

G. 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 o.c. 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 o.c. 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 sq. ft. and to solidly fill space below partitions.
   4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.

H. Sort and select lumber so that natural characteristics will 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.

I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   1. Use inorganic boron for items that are continuously protected from liquid water.
   2. Use copper naphthenate for items not continuously protected from liquid water.

J. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.
   3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

K. 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.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION
   A. Install where indicated and where required for attaching other work. 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.

3.3 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.
   B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Non-structural wall sheathing.
      2. Parapet sheathing.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.4 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.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

2.2 WALL SHEATHING
   A. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
      1. Products: Subject to compliance with requirements, provide one of the following:
         a. CertainTeed Corporation; GlasRoc.
         b. G-P Gypsum Corporation; Dens-Glass Gold.
         c. National Gypsum Company; Gold Bond e(2)XP.
         d. Temple-Inland Inc.; GreenGlass
         e. United States Gypsum Co.; Securock.
      2. Type and Thickness: Regular, 5/8 inch thick.

2.3 PARAPET SHEATHING
   A. Plywood Sheathing: DOC PS 1, Exterior, Structural I sheathing.
      1. Span Rating: Not less than 16/0.
      2. Nominal Thickness: Not less than 1/2 inch unless otherwise indicated on Drawings.
2.4 WOOD PANEL PRODUCTS
   A. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
   B. Factory mark panels to indicate compliance with applicable standard.

2.5 FASTENERS
   A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
      1. For parapet and wall sheathing, provide fasteners of Type 304 stainless steel.
   B. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
      1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
      2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954

2.6 PRESERVATIVE-TREATED PLYWOOD
   A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
      1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
   C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL
   A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
   B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
   C. Securely attach to substrate by fastening as indicated, complying with the following:
      1. NES NER-272 for power-driven fasteners.
      2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
      3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."
   D. Use common wire 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. Install fasteners without splitting wood.
   E. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
   F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
   G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION
   A. Comply with GA-253 and with manufacturer's written instructions.
      1. Fasten gypsum sheathing to cold-formed metal framing with screws.
      2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
      3. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
   B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
   C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.
      1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
   2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

3.3 WOOD STRUCTURAL PANEL INSTALLATION
B. Fastening Methods: Fasten panels as indicated below:
   1. Wall and Roof Sheathing:
      a. Screw to cold-formed metal framing.
      b. Space panels 1/8 inch apart at edges and ends.

END OF SECTION
INTERIOR FINISH CARPENTRY

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. Shelving.
2. Interior plywood paneling.

1.3 DEFINITIONS
A. MDF: Medium-density fiberboard.
B. MDO: Plywood with a medium-density overlay on the face.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
   1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
   2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.
   3. Include copies of warranties from chemical-treatment manufacturers for each type of treatment.
B. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.6 FIELD CONDITIONS
A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
   1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL
A. Lumber: DOC PS 20 and the following grading rules:
   2. WWPA: Western Wood Products Association, "Western Lumber Grading Rules."
B. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
   1. For exposed lumber, mark grade stamp on end or back of each piece.
C. Required Certification: Composite wood products shall contain No Added Urea-Formaldehyde (NAUF) in the product or laminating adhesives used to fabricate the product.

2.2 FIRE-RETARDANT-TREATED MATERIALS
A. General: For applications indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction, and comply with testing requirements; testing by a qualified testing agency.
B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent respectively.
C. For exposed items indicated to receive a stained or natural finish, use organic resin chemical formulations that do not contain colorants, and provide materials that do not have marks from spacer sticks on exposed face.
D. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
E. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
   1. For exposed lumber indicated to receive a stained or natural finish, .
   2. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
F. Application: Where indicated.

2.3 SHELVING AND CLOTHES RODS
A. Closet Shelving: Made from one of the following materials, 3/4 inch thick. Do not use particleboard or MDF that contains urea formaldehyde.
   1. Wood boards as specified above for lumber trim for transparent finish.
B. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.
C. Standards for Adjustable Shelf Supports: BHMA A156.9, B04071; zinc-plated steel.
D. Adjustable Shelf Supports: BHMA A156.9, B04081 or B04091; zinc-plated steel.

2.4 PANELING
A. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1 for painted finish in accordance with section 099100 “Painting”.
   1. Face Veneer Species and Cut: White oak, rift cut.
   2. Backing Veneer Species: Any hardwood compatible with face species.
   3. Construction: Veneer core.
   5. Panel Size: 48 by 96 inches.
   6. Glue Bond: Type II (interior).

2.5 MISCELLANEOUS MATERIALS
A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
B. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.

2.6 FABRICATION
A. Back out or kerf backs of the following members except those with ends exposed in finished work:
   1. Interior standing and running trim except shoe and crown molds.
B. Ease edges of lumber less than 1 inch in nominal thickness to 1/16-inch radius and edges of lumber 1 inch or more in nominal thickness to 1/8-inch radius.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Clean substrates of projections and substances detrimental to application.
B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL
A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, too small to fabricate with proper jointing arrangements, or with defective surfaces, sizes, or patterns.
B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
2. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 PANELING INSTALLATION
A. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.
1. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners. Space fasteners and adhesive as recommended by panel manufacturer.
2. Conceal fasteners to greatest practical extent.
3. Arrange panels with grooves and joints over supports. Fasten to supports with nails of type and at spacing recommended by panel manufacturer. Use fasteners with prefinished heads matching groove color.
4. Nailing: Space nails 4 inches o.c. at panel perimeter and 8 inches o.c. at intermediate supports unless otherwise required by manufacturer.

3.5 ADJUSTING
A. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.6 CLEANING
A. Clean interior finish carpentry on exposed and semiexposed surfaces. Restore damaged or soiled areas and touch up factory-applied finishes, if any.

3.7 PROTECTION
A. Protect installed products from damage from weather and other causes during construction.
B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023
SECTION 064023
INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Wood cabinets.
      2. Shop finishing of interior woodwork.
      3. Cabinet hardware.
   B. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing
      woodwork items unless concealed within other construction before woodwork installation.

1.3 SUBMITTALS
   A. Product Data: For panel products fire-retardant-treated materials cabinet hardware and accessories and
      finishing materials and processes.
      1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by
         treating plant that treated materials comply with requirements.
   B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details,
      attachment devices, and other components.
      1. Show details in sufficient scale to determine compliance with the intent of the Quality Standard
         Grade specified.
      2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and
         reinforcement specified in other Sections.
      3. Show locations and sizes of cutouts and holes for plumbing fixtures installed in architectural
         woodwork.
   C. Samples for Initial Selection:
      1. Shop-applied transparent finishes.
   D. Samples for Verification:
      1. Lumber with or for transparent finish, not less than 50 sq. in., for each species and cut, finished on
         1 side and 1 edge.
      2. Veneer leaves representative of and selected from flitches to be used for transparent-finished
         woodwork.
      3. Veneer-faced panel products with or for transparent finish, 8 by 10 inches, for each species and
         cut. Include at least one face-veneer seam and finish as specified.
      4. Solid-surfacing materials, 6 inches square.
      5. Corner pieces as follows:
         a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18
            inches high by 18 inches wide by 6 inches deep.
         b. Miter joints for standing trim.
      6. Exposed cabinet hardware and accessories, one unit for each type and finish.
   E. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.4 QUALITY ASSURANCE
   A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to
      those required for this Project and whose products have a record of successful in-service performance.
      Shop is a certified participant in AWI's Quality Certification Program.
   B. Installer Qualifications: Certified participant in AWI's Quality Certification Program.
   C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for
      production of interior architectural woodwork with sequence-matched wood veneers and wood doors with
      face veneers that are sequence matched with woodwork.
   D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality
      Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation,
      and other requirements.
   E. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide
      materials and products with specified fire-test-response characteristics as determined by testing identical
products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.6 PROJECT CONDITIONS
A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F 16 and 32 deg C and relative humidity between 25 and 55 percent during the remainder of the construction period.
B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
   2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 COORDINATION
A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS
A. General:
   1. Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
B. Wood Species and Cut for Transparent Finish: As scheduled.
C. Wood Products: Comply with the following:
   2. Medium-Density Fiberboard: ANSI A208.2, Grade as indicated below, made with binder containing no urea formaldehyde.
      b. Type B: MDF, MR30 – ANSI A208.2, Grade 155.
      c. Type C: MDF, MR50 – ANSI A208.2, Grade 150
   3. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde.

2.2 CABINET HARDWARE AND ACCESSORIES
A. General: Provide cabinet hardware and accessory materials as indicated in Master Schedule.
B. Hinges: Frameless Concealed Hinges (European Type), BHMA A156.9, B01602, 135 degrees of opening, self-closing.
C. Pulls: "Cosmopolitan Collection", Item No. 117 97 665 by Haefele; Finish: Brushed nickel.
D. Catches: Magnetic, BHMA A156.9, B03141.
E. Latches: Elbow, BHMA A156.9, B03023.
F. Shelf Rests: BHMA A156.9, B04013; metal.
G. Drawer Slides: BHMA A156.9, B05091.
   1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
   2. File Drawer Slides: Grade 1HD-100; for drawers more than 6 inches high or 24 inches wide.
   3. Pencil Drawer Slides: Grade 2; for drawers not more than 2 inches high and 24 inches wide.
H. Door Locks: BHMA A156.11, E07121; Finish: Satin nickel.
I. Drawer Locks: BHMA A156.11, E07041.
J. Grommets for Cable Passage through Countertops: 2-inch OD, color as selected by Architect from Manufacturers full range, molded-plastic grommets and matching plastic caps with slot for wire passage.  
   1. Product: Subject to compliance with requirements, provide "EDP series" by Doug Mockett & Company, Inc.
K. Grommets for High Finish Areas: 2-inch OD, grommets and match caps with slot for wire passage.  
   1. Subject to compliance with requirements, provide "MM3 series" by Doug Mockett & Company, Inc.
L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.3 MISCELLANEOUS MATERIALS
A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
C. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
D. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Wood Glues: 30 g/L.
   2. Contact Adhesive: 250 g/L.

2.4 FABRICATION, GENERAL
A. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
B. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
C. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
   2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
D. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   1. Seal edges of openings in countertops with a coat of varnish.

2.5 WOOD CABINETS FOR TRANSPARENT FINISH (WS)
A. Grade: Custom.
B. AWI Type of Cabinet Construction: Flush overlay.
C. Panel Product for Exposed Surfaces:
   1. Exposed casework in non-wet areas: Medium-density fiberboard, Type A
   2. Exposed casework in semi-wet areas (restroom and breakrooms with sinks): Medium-density fiberboard, Type B
   3. Exposed casework in wet areas (laboratories, locker rooms, laundry area and cafeteria): Medium-density fiberboard, Type C
D. Wood Species, Cut and Matching for Exposed Surfaces: Refer to Drawings; as scheduled.
   1. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single fitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.
E. Semi-Exposed Surfaces: Provide surface materials indicated below:
   1. Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces.
   2. Drawer Sides and Backs: Solid-hardwood lumber.
   3. Drawer Bottoms: Hardwood plywood.
F. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

G. Provide hardwood “T” banding at door and drawer edges of species, cut and finish to match face veneer.

2.6 SHOP FINISHING
A. General: Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section. Refer to Division 09 painting Sections for finishing opaque-finished architectural woodwork.

B. Shop Priming: Shop apply the prime coat including backpriming, if any, for transparent-finished items specified to be field finished. Refer to Division 09 painting Sections for material and application requirements.

C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
   1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces.

D. Transparent Finish:
   1. Grade: Custom.
   2. AWI Finish System: Catalyzed polyurethane.
   3. Staining: As scheduled
   4. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
   5. Filled Finish for Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.
      a. Apply wash-coat sealer after staining and before filling.
   6. Sheen: As scheduled

PART 3 - EXECUTION

3.1 PREPARATION
A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION
A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.

B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.

C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

F. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
   2. Maintain veneer sequence matching of cabinets with transparent finish.
   3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips or No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

G. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
   1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
3. Secure backsplashes to walls with adhesive.
4. Calk space between backsplash and wall with sealant specified in Division 07 Section “Joint Sealants.”

H. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.
I. Refer to Division 09 Sections for final finishing of installed architectural woodwork not indicated to be shop finished.

3.3 ADJUSTING AND CLEANING
A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
B. Clean, lubricate, and adjust hardware.
C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes penetrating water-repellent treatments for the following vertical and horizontal surfaces:
   1. Limestone coping and veneer where indicated on Drawings.

1.3 PERFORMANCE REQUIREMENTS
A. General Performance: Water repellents shall meet performance requirements indicated without failure due to defective manufacture, fabrication, or installation.
   1. Water Repellents: Comply with performance requirements specified, as determined by preconstruction testing on manufacturer's standard substrate assemblies representing those indicated for this Project.
B. Water Absorption: Minimum 90 percent reduction of water absorption after 24 hours in comparison of treated and untreated specimens.
C. Water Penetration and Leakage through Masonry: Minimum 90 Insert number percent reduction in leakage rate in comparison of treated and untreated specimens, according to ASTM E 514.
D. Durability: Maximum 5 percent loss of water-repellent properties after 2500 hours of weathering according to ASTM G 154 in comparison to water-repellent-treated specimens before weathering.

1.4 PRECONSTRUCTION TESTING
A. Preconstruction Testing: Installed water repellents shall comply with performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard substrate assemblies by a qualified testing agency.

1.5 SUBMITTALS
A. Product Data: For each type of product indicated submit water-repellent manufacturer's literature including product description and written instructions for storage, handling, substrate preparation, protection of surrounding areas not to receive water-repellent, application, and final cleaning.
   1. Include manufacturer's printed statement of VOC content.
   2. Include manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat.
B. Environmental Submittals:
   1. Environmental regulations applicable to site.
   2. Certifications, signed by water-repellent manufacturers, that water repellents comply with environmental regulations applicable to site.
C. Samples: For each type of water repellent and substrate indicated, 8 by 8 inches in size, with specified water-repellent treatment applied to half of each Sample.
D. Applicator Qualifications:
   1. Certification signed by water-repellent manufacturer, certifying that Applicator complies with manufacturer’s requirements to install specified water repellent.
E. Product Certificates: For each type of water repellent, from manufacturer certifying that the product to be used complies with regulations controlling use of VOC.
F. Preconstruction Testing Reports: For each water-repellent-treated substrate, submit third party test reports certifying the specified performance requirements.
G. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE
A. Applicator Qualifications: Qualified firm that is approved, authorized, or licensed by water-repellent manufacturer to install water repellent. Must have installations of specified materials in local area in use for minimum of three years.
   1. Employ foreman trained by water-repellent manufacturer and with minimum of 3-years experience
as foreman on similar projects, to be on site at all times during Work.

B. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements for water-repellent application, including:
   a. Construction schedule and availability of materials, Applicator’s personnel, equipment, and facilities needed to make progress and avoid delays.
   b. Site use, access, staging, and set-up location limitations.
   c. Approved mockup procedures.
   d. Forecast weather conditions.
   e. Surface preparation and substrate condition and pretreatment.
   f. Application procedures.
   g. Minimum curing period.
   h. Testing and inspection requirements.
   i. Site protection measures.
   j. Governing regulations, including environmental regulations, if applicable.

2. Contractor’s site foreman, water-repellent manufacturer’s technical representative, water-repellent Applicator, Owner’s Representative, and Architect/Engineer shall attend.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to Project site in original packages with seals unbroken, labeled with water-repellent manufacturer’s name, product brand name and type, date of manufacture, lot number, and directions for storing.

B. Store materials in original, undamaged containers in clean, dry, protected, cool, well-ventilated location on raised platforms with weather-protective coverings, within temperature range required by water-repellent manufacturer and away from sources of ignition. Protect stored materials from direct sunlight. Water-repellent manufacturer’s standard packaging and covering is not considered adequate weather protection.

C. Limit stored materials on structures to safe loading of structure at time materials are stored, and to avoid permanent deck deflections.

D. Handle materials to avoid damage. Keep containers tightly sealed when not in use, as atmospheric moisture will react with and alter water-repellent solution.

E. Remove and replace materials that cannot be applied within stated shelf life, or that are damaged or otherwise unsuitable.

F. Conspicuously mark damaged or opened containers or containers with contaminated materials, and remove from site as soon as possible.

G. Dispose of unused or unsuitable materials in accordance with water-repellent manufacturer’s recommendations and governing environmental regulations. Do not flush debris or water repellent down existing drains.

1.8 PROJECT CONDITIONS
A. Verify existing dimensions and details prior to installation of materials. Notify Architect/Engineer of conditions found to be different than those indicated in Contract Documents. Architect/Engineer will review situation and inform Contractor and Applicator of changes.

B. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers’ written instructions and warranty requirements:

1. Concrete surfaces and mortar have cured for not less than 28 days.
2. Building has been closed in for not less than 30 days before treating wall assemblies.
3. To substrates that are damp or wet, or that have dew, frost, snow, or ice on them.
4. To substrates below 40 degrees F or less than 5 degrees F above dew point, or above 90 degrees F.
5. When ambient temperature is below 40 degrees F, or is predicted to fall below 40 degrees F within 8 hours after application, or is above 90 degrees F.
6. When rain, snow, fog, or mist is predicted within 24 hours.
7. When wind speeds are at or above 15 miles per hour, or if windy conditions exist that may cause water repellent to be blown onto vegetation or surfaces not intended to be treated.
8. On new concrete or brick masonry exterior walls for at least 30 days following building close-in.

C. Install materials in strict accordance with safety requirements required by water-repellent manufacturer, Material Safety Data Sheets, and local, state, and federal rules and regulations.

D. Maintain adequate ventilation during preparation and application of water-repellent materials. Notify Owner’s Representative at least 1 week in advance of Work with materials with noxious vapors. Review application schedule and venting precautions with Owner’s Representative prior to beginning application.

1.9 WARRANTY
A. Manufacturer’s Warranty: Written warranty, signed by water repellent manufacturer, that the water repellent system will be free of defects related to workmanship or material deficiency for a ten (10) year period from the date of completion of the work provided under this section of the specification. The following performance standards shall be specifically covered under the warranty.
   1. Loss of water repellency:
      a. Using ASTM D 6489 procedure the treated concrete shall not absorb more than 1.0% water by weight for a period of 24 hours.
   2. All defective areas shall be retreated by the system manufacturer as determined by the Architect/Engineer. The required written warranty shall be provided by the system manufacturer.
   3. The Water Repellant Manufacturer shall be responsible for providing labor and material to reseal areas of the substrate where sealer effectiveness does not meet the specified limits.
   4. Provide access to warranty repair and replacement areas.

B. Installer’s Warranty: Written warranty, signed by Applicator, that the water repellent system will be free of defects related to workmanship for a five (5) year period from the date of completion of the work provided under this section of the specification.
   1. Provide access to warranty repair and replacement areas.
   2. Repair or replacement, to satisfaction of Owner, of other work or items which may have been displaced or damaged as consequence of defective work.
   3. Make immediate emergency repairs within 48 hours of notice of loss of water repellancy.

PART 2 - PRODUCTS

2.1 PENETRATING WATER REPELLENTS

A. Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blend with 400 g/L or less of VOCs.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. BASF Construction Chemicals, LLC; Enviroseal 7.
      b. Degussa Corporation; Protectosil Aqua-Trete EM.
      c. Pecora Corporation; KlereSeal 910-W.
      d. PROSOCO, Inc.; Weather Seal GP.
      e. BASF Construction Chemicals; Hydrozo Clear Double 7 VOC.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.
   1. Ensure that Work done by other trades is complete and ready to receive water repellent.
   2. Verify that surfaces are clean and dry according to water-repellent manufacturer’s requirements. Check moisture content in three representative locations by method recommended by manufacturer.
   3. Inspect for previously applied treatments that may inhibit penetration or performance of water repellents.
   4. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
   5. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level according to water-repellent manufacturer’s written instructions to ensure chemical bond to silica-containing or siliceous minerals.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Notify Architect/Engineer in writing of conditions which may adversely affect water-repellent installation or performance. Do not proceed with water-repellent installation until these conditions have been corrected.

3.2 PREPARATION

A. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer’s written instructions and as follows:
   1. Allow wet substrates to dry for at least 24 hours. Verify that substrate is sound and is visibly dry and free of moisture.
   2. Provide clean, dust-free, and dry substrate.
   3. Proceed with application only after unsatisfactory conditions have been corrected. Commencing application constitutes acceptance of work surfaces and conditions.
4. Concrete Unit Masonry: Remove oil, curing compounds, laitance, and other substances that inhibit penetration or performance of water repellents according to ASTM E 1857.

5. Natural Stone: Clean natural stone substrates in accordance with ASTM C 1515 and water repellent manufacturer’s recommendations.

B. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.

C. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured and aged for minimum time period recommended by water-repellent manufacturer.

D. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and for minimum time period recommended by water-repellent manufacturer.

1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.3 APPLICATION

A. Before beginning application

1. Provide and maintain traffic barricades and control measures, well outside limits of wind-drifting, during application and drying of water repellent to protect vehicular and pedestrian traffic from contact with water repellent. Enclose Work area to contain wind-blown overspray.

2. Provide adequate ventilation during and after application of water repellent.

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

C. Apply water repellent at coverage rate demonstrated in mock-up, in uniform manner, using low-pressure spray equipment, brushes, and rollers. Use brooms and squeegees to achieve even distribution. Do not alter or dilute material. Comply with manufacturer’s written instructions for using airless spraying procedure.

1. Prior to use, thoroughly clean spray equipment, tanks, and hoses, and make free of water, foreign matter, and oily residues. Flush with anhydrous alcohol or small amounts of silane.

2. On vertical surfaces, apply from bottom up, with controlled run-down of about 8 inches, with hand-spray unit, brushes, and rollers.

3. Mask mortar and sealant bond surfaces to prevent water repellent from migrating onto joint surfaces.

4. If water-repellent application is not completed at one time, clearly mark location where application is terminated.

5. Allow water repellent to dry for at least 12 hours before exposing to vehicular, construction, or pedestrian traffic.

6. Apply additional coats in accordance with the manufacturer’s recommendations. Comply with manufacturer’s written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer’s technical representative if standard written instructions are not applicable to Project conditions.

3.4 FIELD QUALITY CONTROL

A. Water-repellent manufacturer’s representative shall inspect and approve preparation of substrate and protection of adjacent surfaces before application of water repellent.

B. Testing of Water-Repellant Material: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when water repellent is being applied:

1. Owner will engage the services of a qualified testing agency to sample water-repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.

2. Testing agency will perform tests for compliance of water-repellent material with product requirements.

C. Coverage Test: In the presence of Architect, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application. Test location to be chosen by Architect.

1. Notify Architect seven days in advance of the dates and times when surfaces will be tested.

2. Reapply water repellent until coverage test indicates complete coverage at no cost to Owner.

3.5 CLEANING
A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application, as approved by Architect.

B. Comply with manufacturer’s written cleaning instructions.

END OF SECTION
SECTION 072100

THERMAL INSULATION

PART 1 - GENERAL

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

1.2 RELATED WORK IN OTHER SECTIONS
A. Section 098116 “Acoustical Blanket Insulation” for batt-type, concealed acoustical insulation.

1.3 SUMMARY
A. Section Includes:
   1. Foam-plastic board insulation.
   2. Glass-fiber blanket insulation.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE
A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer’s written instructions for handling, storing, and protecting during installation.
B. Protect foam-plastic board insulation as follows:
   1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
   3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION (continuous insulation outboard of metal studs)
A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. DiversiFoam Products.
      b. Dow Chemical Company (The).
      c. Owens Corning.
      d. Pactiv Building Products.
   2. Type IV, 25 psi.
B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
C. Thickness: As required to achieve minimum R-7.5 unless otherwise indicated.
2.2 GLASS-FIBER BLANKET INSULATION (within exterior metal studs)
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. CertainTeed Corporation.
      2. Guardian Building Products, Inc.
      5. Owens Corning.
   B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
   C. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:
      1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
      2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.
   D. Thickness: As required to achieve minimum R-19.

2.3 MINERAL-WOOL BLANKET INSULATION
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Fibrex Insulations Inc.
      2. Owens Corning.
      3. Roxul Inc.
      4. Thermafiber.
   B. Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

PART 3 - EXECUTION

3.1 PREPARATION
   A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL
   A. Comply with insulation manufacturer’s written instructions applicable to products and applications indicated.
   B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
   C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
   D. Provide sizes to fit applications indicated and selected from manufacturer’s standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF CAVITY-WALL INSULATION
   A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.
      1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION
   A. Apply insulation units to substrates by method indicated, complying with manufacturer’s written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
   B. Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
   C. Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
      1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

3.5 PROTECTION
A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION
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KOMATSU ARCHITECTURE PROJECT NO. 2018.118

SECTION 072600

UNDER SLAB VAPOR BARRIER

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. Sheet materials for controlling vapor diffusion through concrete slabs-on-grade.

1.3 SUBMITTALS
A. Written certification from the manufacturer that the materials and their application as noted in this Specification and on the Drawings is appropriate and approved for this project.
B. Product Data: Manufacturer's product data, specifications, and installation instructions. Include vapor barrier manufacturer's requirements for placement, seaming and pipe book installation.
C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.
D. Submit evidence that Installer™s existing company has minimum of 5-years continuous experience in application of specified materials.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: An experienced installer (applicator) who is acceptable to manufacturer, who has completed applications similar in material and extent to that required for this Project, and whose work has resulted in construction with a record of successful in-service performance.
B. Source Limitations: Vapor Barrier and components to be from one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and application.
B. Store materials in a clean dry location in accordance with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.
C. Stack membrane on elevated wood platform to eliminate warping.
D. Protect materials during handling and application to prevent damage or contamination.

1.6 PROJECT CONDITIONS
A. Environmental Limitations: Comply with manufacturer's written recommendations for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting materials performance. Do not apply on frozen ground.
B. Close areas to traffic during application and for time period after application recommended in writing by manufacturer.

1.7 COORDINATION
A. Coordinate placement of sheet vapor barrier with Division 03 sections.
B. Coordinate placement of sealer and hardener with Division 03 sections and with requirements of finish flooring products, including adhesives, specified in Division 09 Sections.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Sheet Vapor Barrier:
   1. Type: 15 mil polyolefin film meeting requirements of ASTM E 1745, Class A.
   2. Water Vapor Transmittance (After mandatory condition per ASTM E154 sections 8,11,12,13): Maximum perm rating of 0.01 as tested in accordance with ASTM E 1745 Section 7.
   3. **Strength:** ASTM E 1745: Class A.
B. Acceptable Products:
1. Subject to compliance with requirements, provide one of the following:
   a. Stego Wrap Vapor Barrier by Stego Industries, LLC, 15 mils.
   c. Xtreme by Tex-Trude.
   d. Husky Yellow Guard.

C. Accessories:
   1. Bonding Agent: Manufacturer’s approved or recommended vapor barrier bonding agent.
   2. Sealing and Seaming Tape: High density polyethylene tape a minimum of 4 inches in width, compatible with vapor barrier membrane, and manufactured by or recommended by vapor barrier membrane manufacturer. Tape for joints shall have at least the same permeability rating as the vapor barrier specified.
   3. Vapor Proofing Mastic: Manufacturer’s approved or recommended vapor proofing mastic with the same permeability rating as the vapor barrier specified.
   4. Pipe Boot: Construct pipe boots from vapor barrier material and pressure sensitive tape in accordance with manufacturer’s instructions.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine surfaces to receive membrane. Notify Architect if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.

3.2 PREPARATION
   A. Level or tamp or roll aggregate, sand or granular base.

3.3 INSTALLATION
   A. Vapor Barrier:
      1. Place, protect, and repair vapor barrier sheets according to ASTM E 1643 and manufacturer’s written instructions.
      2. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete pour.
      3. Install vapor barrier without tears, voids, and holes. Lap ends and edges as recommended by manufacturer, but not less than 6 inches over adjacent sheets. Seal laps with tape.
      4. Turn up sheets at perimeter, at footings and vertical walls, and against penetrations, and seal joints with tape.
      5. Seal joints, tears, holes, perimeter, and penetrations through vapor with tape in accordance with manufacturer’s recommendations.
      6. Point exposed edges with pointing mastic to prevent water from traveling under membrane.
      7. Adhere membrane to vertical surfaces with adhesive.

3.4 PROTECTION
   A. Protect complete membrane from damage. Prior to pouring concrete, inspect membrane for punctures or damage and repair as required to maintain vapor barrier integrity.

END OF SECTION
SECTION 072726

FLUID-APPLIED MEMBRANE AIR BARRIERS

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 fluid-applied, vapor-permeable membrane air barriers.

1.3 DEFINITIONS
A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.
B. Shop Drawings: For air-barrier assemblies.
   1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   2. Include details of interfaces with other materials that form part of air barrier.

1.6 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by the Installer, who will work on Project.
B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.

1.7 QUALITY ASSURANCE
A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
   1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
B. Mockups: Build mockups to set quality standards for materials and execution.
   1. Build integrated mockups of exterior wall assembly, 150 sq. ft. incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
      a. Coordinate construction of mockups to permit inspection by Owner's testing agency of air barrier before external insulation and cladding are installed.
      b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
      c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
   B. Protect stored materials from direct sunlight.

1.9 FIELD CONDITIONS
   A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
      1. Protect substrates from environmental conditions that affect air-barrier performance.
      2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL
   A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS
   A. General: Air barrier shall be capable of performing as a continuous vapor-retarding permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.3 VAPOR-PERMEABLE MEMBRANE AIR-BARRIER
   A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: Elastomeric, modified bituminous or synthetic polymer membrane.
      1. Products: Subject to compliance with requirements, provide one of the following:
         a. Elastomeric, Modified Bituminous Membrane:
            1) Meadows, W. R., Inc.; Air-Shield LMP.
         b. Synthetic Polymer Membrane:
            1) Grace, W. R., & Co. - Conn.; Perm-A-Barrier VPO.
            2) Henry Company; Air-Bloc 33 at rainscreen applications.
      2. Physical and Performance Properties:
         a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
         b. Vapor Permeance: Minimum 10 perms; ASTM E 96/E 96M.
         c. Ultimate Elongation: Minimum 200> percent; ASTM D 412, Die C.
         d. UV resistant.
         e. Color: Black.

2.4 ACCESSORY MATERIALS
   A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.
   B. Primer: Liquid waterborne primer recommended for substrate by air-barrier material manufacturer.
   C. Butyl Strip: Vapor retarding, 30 to 40 mils thick, self-adhering; polyethylene-film-reinforced top surface laminated to layer of butyl adhesive with release liner backing.
   D. Joint Reinforcing Strip: Air-barrier manufacturer's glass-fiber-mesh tape.
   E. Adhesive and Tape: Air-barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.
   F. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.0187 inch thick, and Series 300 stainless-steel fasteners.
   G. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft density; flame-spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.
H. Modified Bituminous Transition Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil-thick polyethylene film with release liner backing.

I. Preformed Silicone-Sealant Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 123 Silicone Seal.
      b. Pecora Corporation; Sil-Span.
      c. Tremco Incorporated, an RPM company; Spectrem Simple Seal.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
      1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
      2. Verify that concrete has cured and aged for minimum time period recommended by air-barrier manufacturer.
      3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
      4. Verify that masonry joints are flush and completely filled with mortar.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION
   A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.
   B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
   C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
   D. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
   E. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 JOINT TREATMENT
   A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
      1. Prime substrate and apply a single thickness of air-barrier manufacturer's recommended preparation coat extending a minimum of 3 inches along each side of joints and cracks. Apply a double thickness of fluid air-barrier material and embed a joint reinforcing strip in preparation coat.
   B. Gypsum Sheathing: Fill joints greater than 1/4 inch with sealant according to ASTM C 1193 and air-barrier manufacturer's written instructions. Apply first layer of fluid air-barrier material at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air-barrier material over joint reinforcing strip.

3.4 TRANSITION STRIP INSTALLATION
   A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
   B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
   C. Connect and seal exterior wall air-barrier material continuously to concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
D. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition strip preformed silicone-sealant extrusion so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact.
1. Modified Bituminous Transition Strip: Roll firmly to enhance adhesion.
2. Preformed Silicone-Sealant Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

E. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.

F. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

G. Seal top of through-wall flashings to air barrier with an additional 6-inch-wide, strip.

H. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

A. General: Apply fluid air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.
1. Apply primer to substrates at required rate and allow it to dry.
2. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.

B. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
1. Vapor-Permeable Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 40-mil dry film thickness.

C. Apply strip and transition strip a minimum of 1 inch onto cured air-barrier material or strip and transition strip over cured air-barrier material overlapping 3 inches onto each surface according to air-barrier manufacturer's written instructions.

D. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Continuous structural support of air-barrier system has been provided.
3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
4. Site conditions for application temperature and dryness of substrates have been maintained.
5. Maximum exposure time of materials to UV deterioration has not been exceeded.
6. Surfaces have been primed, if applicable.
7. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
8. Strips and transition strips have been firmly adhered to substrate.
9. Compatible materials have been used.
10. Transitions at changes in direction and structural support at gaps have been provided.
11. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
12. All penetrations have been sealed.

C. Tests: As determined by Owner's testing agency from among the following tests:
1. Qualitative Air-Leakage Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E 1186, smoke pencil with pressurization or depressurization.

D. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
2. Remove and replace deficient air-barrier components for retesting as specified above.

E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.7 CLEANING AND PROTECTION
A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
   1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 30 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
   2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
C. Remove masking materials after installation.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Section 077253 “Snow Guards” for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.2 SUMMARY
A. Section Includes:
   1. Standing-seam metal roof panels including flashings and accessories.
   2. Metal soffit panels including flashings and accessories.

1.3 DEFINITIONS
A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.
B. See ASTM D 1079 and glossary of NRCA’S “The NRCA Roofing and Waterproofing Manual” for definition of terms related to metal roofing work in this Section.
C. Roofing System Manufacturer: Any of the manufactures whose systems are specified under “Acceptable Roofing System Manufacturers”, herein called “manufacturer”.

1.4 PERFORMANCE REQUIREMENTS
A. General Performance: Metal roof panels shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
B. Delegated Design: Design metal roof panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
C. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of roof area when tested according to ASTM E 1680 at the following test-pressure difference:
   1. Test-Pressure Difference: Negative 1.57 lbf/sq. ft.
   2. Test-Pressure Difference: Positive and negative 1.57 lbf/sq. ft.
   3. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
   4. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.
D. Water Penetration: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
   1. Test-Pressure Difference: 20 percent of positive design wind pressure, but not less than 6.24 lbf/sq. ft.
   2. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
   3. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.
E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   1. Uplift Rating: UL 90.
G. Structural Performance: Provide metal roof panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592-95:
   1. Design Wind Loads: As indicated on structural drawings or as otherwise determined using design wind loads applicable to Project from basic wind speed indicated in miles per hour, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure."
   2. Deflection Limits: Metal roof panel assemblies shall withstand wind and snow loads with vertical deflections no greater than L/240 of the span.
H. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
   I. Thermal Performance: Provide insulated metal roof assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 518.
   J. Energy Performance: Provide roof panels with solar reflectance index (SRI), (Steep Slope Roof – 2:12 or Greater), of not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency, unless otherwise indicated on the Drawings.

1.5 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of roof panel and accessory.
B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, side-seam and endlap joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
   1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches1:10:
      a. Flashing and trim.
C. Samples for Initial Selection: For each type of metal roof panel indicated with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.
D. Delegated-Design Submittal: For metal roof panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
E. Manufacturer Certificates: Signed by manufacturer certifying that roof panels comply with energy performance requirements specified in “Performance Requirements” Article.
   1. Submit evidence of meeting performance requirements.
F. Qualification Data: For qualified Installer.
G. Field quality-control reports.
H. Warranties: Samples of special warranties.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
C. Source Limitations: Obtain each type of metal roof panels from single source from single manufacturer.
D. Fire-Resistance Ratings: Where indicated, provide metal roof panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL’s “Fire Resistance Directory” or from the listings of another qualified testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

1.8 PROJECT CONDITIONS
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal roof panel work to be performed according to manufacturer’s written instructions and warranty requirements.
B. Field Measurements: Verify actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

1.9 COORDINATION
A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
B. Coordinate metal roof panels with rain drainage work, flashing, trim, and construction of decks, purlins and rafters, parapets, walls, and other adjoining work to provide a leak-proof, secure, and non-corrosive installation.

1.10 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including rupturing, cracking, or puncturing.
   b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Weathertight Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS
A. Metallic-Coated Steel Sheet: 24 gauge (min.) G-90 (ASTM-A525) Restricted flatness steel sheet metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A 755/A 755M.

1. 2-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color: As indicated on Drawings.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
   a. Color: As indicated on Drawings.

2.2 UNDERLAYMENT MATERIALS
A. Self-Adhering, High-Temperature Sheet: 30 to 40 mils thick minimum, consisting of slip-resisting, polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
3. Products: Subject to compliance with requirements, provide one of the following:
   a. Carlisle Coatings & Waterproofing Inc., Div. of Carlisle Companies Inc.; CCW WIP 300HT.
   c. Henry Company; Blueskin PE200 HT.

2.3 MISCELLANEOUS METAL FRAMING
A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653, G90 hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.

B. Hat-Shaped, Rigid Furring Channels:
1. Nominal Thickness: As required to meet performance requirements.
2. Depth: 7/8 inch.

C. Cold-Rolled Furring Channels: Minimum 1/2-inch wide flange.
1. Nominal Thickness: As required to meet performance requirements.
2. Depth: 3/4 inch.
3. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with nominal thickness of 0.040 inch.
4. Tie Wire: ASTM A 641, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

D. Z-Shaped Furring: With slotted or non-slotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, and depth required to fit insulation thickness indicated.
   1. Nominal Thickness: As required to meet performance requirements.

E. Stainless Steel Fasteners for Miscellaneous Metal Framing: Of type, size, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

2.4 MISCELLANEOUS MATERIALS
A. Stainless Steel Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.


E. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.

2.5 STANDING-SEAM METAL ROOF PANELS
A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
   1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and snapping panels together.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MBCI; a division of NCI Building Systems, L. P.
      b. McElroy Metals.
      c. Petersen Aluminum Corporation.
   2. Clips: Floating to accommodate thermal movement.
      a. Material: 0.025-inch min- thick, stainless-steel sheet.
   4. Panel Rib Height: Match existing.

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

B. Flush-Profile Metal Soffit Panels: Panels to match existing formed with vertical panel edges and flat pan between panel edges; with flush joint between panels.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Architectural Building Components Houston, Texas
      b. MBCI; a division of NCI Building Systems, L. P. (Basis of Design: Artisan)
      c. Petersen Aluminum Corporation.
   2. Material: Aluminum-zinc alloy-coated steel sheet, 0.034-inch nominal thickness.
      a. Exterior Finish: 2-coat fluoropolymer
      b. Color: As scheduled.
   3. Panel Coverage: 8 inches.
   4. Panel Height: 1 inch.
   5. Sealant Refer to Division 7 section “Joint Sealants”.

C. Roof Panel Accessories: Provide components approved by roof panel manufacturer and as required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips,
METAL ROOF PANELS

1. **Flashings, sealants, gaskets, fillers, closure strips, and similar items.** Match material and finish of metal roof panels unless otherwise indicated.
   1. **Closures:** Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
   2. **Closure Strips:** Closed-cell, expanded, cellular, rubber or cross-linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch thick, flexible closure strips; cut or pre-molded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
   3. **Backing Panel:** Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

2. **Flashings and Trim:** Formed from same material as roof panels, pre-painted with coil coating, minimum 0.018 inch thick. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

2.7 **FABRICATION**

A. Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer’s standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal roof panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weathertight and minimize noise from movements within panel assembly.

D. **Sheet Metal Accessories:** Fabricate flashing and trim to comply with recommendations in SMACNA’s “Architectural Sheet Metal Manual” that apply to the design, dimensions, metal, and other characteristics of item indicated.
   1. **Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.**
   2. **End Seams for Aluminum:** Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   3. **End Seams for Other Than Aluminum:** Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   4. **Sealed Joints:** Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
   5. **Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.**
   6. **Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA’s “Architectural Sheet Metal Manual” or by metal roof panel manufacturer for application, but not less than thickness of metal being secured.**

2.8 **FINISHES**

A. Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. **Appearance of Finished Work:** Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 **EXAMINATION**

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

B. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

C. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

D. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.
E. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
B. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer’s written instructions.
   1. Soffit Framing: Clip furring channels to supports as required to comply with requirements for assemblies indicated.

3.3 UNDERLAYMENT INSTALLATION
A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days after installation.
   1. Install beneath entire roof surface.
B. Install flashings to cover underlayment to comply with requirements specified in Division 07 Section “Sheet Metal Flashing and Trim.”

3.4 METAL ROOF PANEL INSTALLATION, GENERAL
A. Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
B. Thermal Movement: Rigidly fasten metal roof panels to structure at one and only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction. Predrill panels for fasteners.
   1. Avoid attaching accessories through roof panels in a manner that will inhibit thermal movement.
C. Install metal roof panels as follows:
   1. Commence metal roof panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.
   2. Field cutting of metal panels by torch is not permitted.
   3. Install panels perpendicular to purlins.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Provide metal closures at rake edges.
   6. Flash and seal metal roof panels with weather closures at eaves, rakes, and perimeter of all openings.
   7. End Splices: Locate panel end splices over, but not attached to, structural supports. Stagger panel end splices to avoid a four-panel splice condition.
   8. Install metal flashing to allow moisture to run over and off metal roof panels.
D. Fasteners:
   1. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and stainless-steel fasteners for surfaces exposed to the interior.
E. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer’s approved fasteners according to manufacturers’ written instructions.
F. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
   1. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.
G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
   1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.
   2. Prepare joints and apply sealants to comply with requirements in Division 07 Section “Joint Sealants.”

METAL ROOF PANELS
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3.5 METAL ROOF PANEL INSTALLATION
A. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
   3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.

3.6 METAL SOFFIT PANEL INSTALLATION
A. In addition to complying with requirements in "Metal Roof Panel Installation, General" Article, install metal soffit panels to comply with requirements in this article.
B. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.
   1. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.
C. Metal Fascia Panels: Align bottom of panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

3.7 ACCESSORY INSTALLATION
A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

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

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

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

END OF SECTION
SECTION 074210.11
COMPOSITE FRAMING SUPPORT (CFS) SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Composite framing support (CFS) system with in-fill insulation integrated with [metal wall panels] [brick veneer] [CMU veneer] [phenolic panels] [fiber cement panels] [terra cotta] or [<_____>] exterior wall cladding.
   1. Substrate: [Exterior sheathing over metal stud framing] [Exterior sheathing over wood stud framing] [Concrete masonry units (CMU)] or [Poured concrete].

1.2 RELATED REQUIREMENTS
A. Section 03 3000 – Cast-in-Place Concrete: Concrete wall substrate
B. Section 04 2000 – Unit Masonry: Concrete masonry unit (CMU) wall substrate
C. Section 05 4000 – Cold-Formed Metal Framing: Metal stud substrate support framing
D. Section 06 1000 – Rough Carpentry: Exterior sheathing and wood stud substrate support framing
E. Section 07 2500 – Weather Barriers: Air, water, vapor barrier at exterior wall
F. Section 07 4200 – Wall Panels: Wall cladding system
G. Section 07 9200 – Joint Sealants: Perimeter sealant
H. Section 09 2116 – Gypsum Board Assemblies: Exterior sheathing

1.3 REFERENCE STANDARDS
A. ASCE American Society of Civil Engineers (www.asce.org)
   1. ASCE 7 – Minimum Design Loads for Buildings and Other Structures; 2010 with Supplements and Errata
   2. ASCE – Structural Plastics Design Manual
B. ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers (www.ashrae.org)
C. ASTM International (American Society for Testing and Materials; www.astm.org)
   1. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015
   8. ASTM C1395/C1396M – Standard Specification for Gypsum Board; 2014a
   11. ASTM D635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2014
   13. ASTM D696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between minus 30 degrees C and 30 degrees C with a Vitreous Silica Dilatometer; 2008e1

F. IgCC – International Green Construction Code; 2012
G. NFPA – National Fire Protection Association (www.nfpa.org)
H. Voluntary Product Standard; National Institute of Standards and Technology (NIST)
1. PS 1 – Structural Plywood; 2009

1.4 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate construction of wall cladding support system over substrate indicated for proper drainage, flashing, trim, back-up support, soffits, and other related Work.
1. Review and finalize construction schedule.
2. Verify availability of materials, installer's personnel, equipment, and facilities needed to maintain schedule.
3. Review means and methods related to installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment and attachment to structural support system.
5. Review flashings, wall cladding details, wall penetrations, openings, and condition of other construction that affects this Work.
6. Review temporary protection requirements for during and after installation of this Work.

1.5 SUBMITTALS
A. See Section 01 3000 – Administrative Requirements, for submittal procedures.
B. Product Data: Submit for each type of product indicated; include construction details, material descriptions, dimensions of individual components and profiles, and accessories as necessary for complete fully functioning and assembled system.
1. Continuous insulation support system attachment methods and required fasteners
2. Wall-mounted items including doors, windows, louvers, and lighting fixtures
3. Wall penetrations including pipes, electrical fixtures, and any other utilities
C. Test and Inspection Reports: Submit test and inspection reports on each type of wall cladding/veneer system based on evaluation of comprehensive tests performed by nationally recognized testing agency.
D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with at least three years of documented experience.
B. Installer: Company specializing in performing work of this section and the following:
1. Install system in strict compliance with manufacturer's installation instructions.
2. Have not less than three years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to site in manufacturer's original unopened containers and packaging with labels clearly identifying product name and manufacturer.
B. Deliver components and other manufactured items or accessories without damage or deformation.
C. Storage: Store materials in clean, dry, and level interior areas or outdoor areas for limited duration in accordance with manufacturer's written instructions.
D. Protect components and auxiliary accessories during transportation, handling, and installation from moisture, excessive temperatures and other construction operations in accordance with manufacturer’s written instructions.

E. Handle components in strict compliance with manufacturer’s written instructions and recommendations, and in a manner to prevent bending, warping, twisting, and surface, edge or corner damage.

1.8 SITE CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of this Work in accordance with manufacturer’s written installation instructions and warranty requirements.

1.9 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. CFS System Warranty: Provide written warranty by manufacturer agreeing to correct defects in manufacturing within [five year] or [<_____>] period after Date of [Delivery] or [Substantial Completion].

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Advanced Architectural Products (A2P): SMARTci GreenGirt 1-in-1 System

1. Address: 959 Industrial Drive, Allegan, Michigan 49010.
2. Phone: (269) 355-1818; Fax: (866) 858-5568; Website: www.smartcisisystems.com
3. Other products shall be pre-submitted and approved products that meet materials and performance requirements with specified and validated third party testing.

2.2 DESCRIPTION

A. Attach CFS system components to [exterior sheathing over metal stud framing] [exterior sheathing over wood stud framing] [concrete masonry units (CMU)] or [poured concrete].

1. Refer to Section 05 4000 for metal stud framing.
2. Refer to Section 06 1000 for wood stud framing.
3. Refer to Section 03 3000 for concrete substrate.
4. Refer to Section 04 2000 for CMU substrate.

B. Install CFS system components [horizontally] or [vertically] on framed sheathing substrate system as indicated on drawings in compliance with specified requirements.

C. Install CFS system components [horizontally] or [vertically] on masonry or concrete substrate system with shims as indicated on drawings in compliance with specified requirements.

2.3 PERFORMANCE REQUIREMENTS

A. System Thermal Design: Ensure installed insulation and CFS system, sub-framing, clips and cladding attachment does not have thermal bridging of fasteners or framing that creates a continuous metal path from exterior surface of insulation to interior face of insulation.

1. System thermal design shall meet or exceed thermal design requirements in compliance with [ASHRAE 90.1] [ASHRAE 189.1] [IECC] or [IgCC] energy code.
2. Thermal Resistance: Wall assembly R Value of [<____>].
3. Thermal Performance Test: Provide thermal resistance (R-value) indicated, in compliance with ASTM C1363, corrected to 15 mph outside and still air inside, with installed condition including fastening and joints.
   a. Provide efficiency of no less than [93 to 98 percent] or [<_____]percent], with a maximum temperature differential of 18 degrees F from interior wall surface to interior wall cavity and node locations with a 70 degrees F exterior to interior wall temperature delta.
   b. Provide test unit with at least one insulation panel horizontal and vertical joint length and height of test chamber area.
   c. Provide finite element analysis of three-dimensional simulation of described wall assembly sealed by professional engineer in compliance with performance requirements and exceeding it by at least 3 percent.

B. Temperature: Comply with structural loading requirements within temperature range of minus 55 degrees F to 180 degrees F.

C. Fire-Test-Response Characteristics: Provide composite framing support system with fire-test results indicated as determined by test standard indicated and applied by UL or other testing and inspection agency acceptable to authorities having jurisdiction.
1. Surface Burning Characteristics: In compliance with ASTM E84, for foam insulation, fiber reinforced polymer (FRP) and interior surfaces as follows:
   a. Flame Spread Index (FSI): 25 or less.
   b. Smoke Developed Index (SDI): 450 or less.

2. Intermediate Scale Multistory Fire Test: Comply with NFPA 285 and/or IBC acceptance criteria for wall height above grade and fire separation distances, when wall type and other noted conditions require such testing or compliance with requirements as indicated.

2.4 COMPOSITE FRAMING SUPPORT (CFS) SYSTEM

A. CFS System: Provide CFS system consisting of polyester and vinyl ester bioresin matrix (FRP) with recycled materials, fire retardant additives and integral continuous metal inserts the length of profile. Reinforce CFS system with glass strand rovings used internally for longitudinal (lengthwise) strength and continuous strand glass mats or stitched reinforcements used internally for transverse (crosswise) strength.

1. Depth of GreenGirt: [2 inch] [2-1/2 inch] [3 inch] [3-1/2 inch] [4 inch] [4-1/2 inch] [5 inch] [5-1/2 inch] or [6 inch] deep.

2. On Center Spacing: [16 inch] [24 inch] [32 inch] [36 inch] or [48 inch].

3. Provide continuous non-corrosive steel insert for engagement of fasteners, at least 16 gage thick with G90 galvanized coating designation in compliance with ASTM A653/A653M.
   a. Fully engage steel insert with adjacent CFS at ends.
   b. Anchor sub-girts and other wall cladding support accessories to steel insert set into and part of CFS.
   c. Provide screw pullout testing that meets or exceeds [<_____ lbs>].

4. Provide integral compression seal in CFS sections to ensure insulation panel will not dislodge.

5. Provide integral anti-siphon grooves on exterior and interior flanges of CFS.

6. Provide force distribution zones integrally designed into profile of CFS.

7. Surface Burning Characteristics:
   a. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84.
   b. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.

8. Flammability: Comply with ASTM E84.


11. Tensile Stress: Provide engineered lengthwise and crosswise tensile stress in compliance with performance loading criteria and specified safety factors, in accordance with ASTM D638.

12. Compressive Stress: Provide engineered lengthwise and crosswise compressive stress in compliance with performance loading criteria and specified safety factors, in accordance with ASTM D695.

13. Flexural Stress: Provide engineered lengthwise and crosswise flexural stress in compliance with performance loading criteria and specified safety factors, in accordance with ASTM D790.

2.5 INSULATION

A. Mineral Fiber Board Insulation: Rigid or semi-rigid mineral fiber, ASTM C612 or ASTM C553.

1. Unfaced – Flame Spread Index: Zero (0) when tested in accordance with ASTM E84.

2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.

3. Board Size: [16 by 48 inches] [24 by 48 inches] [36 by 48 inches] or [(__) by (__) inches].

4. Board Thickness: [2 inch] [2-1/2 inch] [3 inch] [3-1/2 inch] or [(__) inch].

5. Thermal Resistance: R-Value of [4.2] or [_____] at 75 degrees F, minimum, when tested according to ASTM C518.

6. Compressive Resistance: ASTM C612, [Type IB, 25 psf] [Type II, 25 psf] or [Type III, 12 psf], minimum.
7. Acceptable Products:
   a. Johns Manville; Product MinWool Curtainwall (www.jm.com)
   b. Thermafiber, Inc.; Product RainBarrier HD (www.thermafiber.com)
   c. ROXUL, Inc; Product Roxul Plus Metal Building (www.roxul.com)
   d. Substitutions: See Section 01 6000 - Product Requirements

B. Sprayed Polyurethane Foam (SPF) Insulation: Medium-density, rigid or semi-rigid, open or closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
1. Conform to applicable code requirements for [flame and smoke] [concealment] or [overcoat] limitations.
2. Thickness: [2 inch] [2-1/2 inch] [3 inch] [3-1/2 inch] or [(___) inch].
3. Thermal Resistance: R-Value of 5, minimum, when tested at 1 inch thickness in accordance with ASTM C518.
5. Air Permeance: Maximum of 0.004 cfm/sq ft, tested at intended thickness in accordance with ASTM E2178 or ASTM E283 at 1.5 psf.
6. Water Absorption: Maximum of 2 percent by volume, tested in accordance with ASTM D2842.
7. Surface Burning Characteristics: Maximum flame spread index/smoke developed index of 25/450, tested in accordance with ASTM E84.
8. Acceptable Products:
   a. BASF Corporation; Product WALLTITE US (www.spf.basf.com)
   b. Demilec LLC; Product HEATLOK SOY 200 (www.demilec.com)
   c. Icynene Inc; Product ProSeal Eco (www.icynene.com)
   d. Substitutions: See Section 01 6000 - Product Requirements

2.6 ASSEMBLY
A. Assemble CFS system using manufacturer’s standard procedures and processes identical to tested units and as necessary to comply with performance requirements indicated.
1. Comply with CFS system and dimensional and structural requirements as indicated on drawings.
2. Erect CFS system in established sequence in accordance with manufacturer’s standard installation procedures.
3. Provide spray foam sealant on backside of cantilevered fasteners that completely puncture insulation layer.

2.7 ACCESSORIES
A. Provide accessories necessary for complete CFS system including [metal closure trim] [transition angle] [strapping] [tie-in brackets] or [(___)] and similar items.
B. Fasteners: Corrosion-resistant, self-tapping and self-drilling screws, bolts, nuts, and other fasteners as recommended by CFS system manufacturer for project application.
2. CFS System to Metal Stud Wall Framing: Use standard self-tapping metal screws.
3. CFS System to Concrete/CMU: Use standard masonry or concrete screw anchors in predrilled hole.
4. CFS System to Wood Framing: Use standard wood screw anchors.
5. DO NOT USE powder, air, or gas actuated fasteners or actuated fastener tools. DO NOT USE impact wrenches when fastening to or from the CFS.
C. Wall Sheathing: Plywood, PS 1, Grade C-D, Exposure I.
1. Refer to drawings for thickness and Section 06 1000 for additional requirements.
D. Wall Sheathing: Gypsum board, complying with requirements of ASTM C1396/C1396M for gypsum sheathing, V-shaped long edges, Type X fire-resistant.
1. Refer to drawings for thickness and [Section 06 1000] or [Section 09 2116] for additional requirements.
E. Wall Sheathing: Glass mat faced gypsum, ASTM C1177/C1177M, square long edges, Type X fire-resistant.
1. Refer to drawings for thickness and [Section 06 1000] or [Section 09 2116] for additional requirements.
F. Sealants: Refer to Section 07 9200 for sealant information.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas of this work, and project conditions with installer present for compliance with requirements for installation tolerances, substrates, CFS system conditions, and other conditions affecting performance of this Work.
B. Examine structural wall framing to ensure that angles, channels, studs, and other structural support members have been installed within alignment tolerances required by CFS system manufacturer.
C. Examine rough-in for components and systems penetrating CFS system to coordinate actual locations of penetrations relative to CFS systems joint locations prior to installation.
D. Verify that mechanical and electrical services for exterior walls have been installed and tested and, if appropriate, verify that adjacent materials and finishes are dry and ready to receive insulation.
E. Proceed with installation only after wall substrate surfaces have been properly prepared and unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Clean surfaces thoroughly prior to installation.
B. Prepare surfaces using methods recommended by CFS manufacturer for achieving best result for substrate under project conditions.
C. Prepare sub-framing, base angles, sills, furring, and other CFS system members and provide anchorage in accordance with ASTM C754 for substrate type and wall cladding type in accordance with manufacturer’s installation instructions.

3.3 INSTALLATION
A. Install CFS system in accordance with manufacturer’s installation instructions.
B. Install system to fill-in exterior spaces without gaps or voids, and do not compress insulation panels.
C. Trim insulation neatly to fit spaces, and insulate miscellaneous gaps and voids.
D. Fit insulation tight in spaces and tight to exterior side of Mechanical/Electrical services within plane of insulation.
E. Exposed insulation must be protected from open flame.
F. Exterior wall insulation is not intended to be left exposed for extended periods of time without adequate protection.
G. Install CFS system in compliance with system orientation, sizes, and locations as indicated on drawings.

3.4 TOLERANCES
A. Shim and align CFS system within installed tolerances of 1/4 inch in 20 feet, non-cumulative, level, plumb, and on location lines as indicated.

3.5 PROTECTION
A. Protect installed products from damage until Date of Substantial Completion.
B. Ensure that insulation panels are not exposed to moisture.
   1. Remove wet insulation panels or allow them to completely dry prior to installation of CFS system.
C. Replace damaged insulation prior to Date of Substantial Completion.

END OF SECTION
SECTION 074213
METAL PANEL RAINSCREEN

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Decorative coating aluminum metal panel rainscreen system.

1.2 RELATED REQUIREMENTS
A. Section 054000 – Cold-Formed Metal Framing: Wall panel substrates support framing.
B. Section 061600 – Sheathing: Rainscreen substrate wall sheathing.
C. Section 072726 – “Fluid Applied Air Barriers: Air and moisture barrier required as part of metal wall panel assembly.
D. Section 076200 – Sheet Metal Flashing and Trim: Field formed flashings and other sheet metal work.
E. Section 079200 – Joint Sealers: Perimeter sealant.

1.3 DEFINITION
A. Metal Plate Wall Panel Assembly: Metal plate wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weather tight wall system based on AAMA CW-RS-1.

1.4 REFERENCE STANDARDS
A. AAMA - American Architectural Manufacturers Association (www.aamanet.org)
   1. AAMA CW-RS-1 – The Rain Screen Principle and Pressure Equalized Wall Design; 2004
   3. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2009
   4. AAMA 508 – Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems; 2007
B. ASTM International (American Society for Testing and Materials; www.astm.org)
   2. ASTM C 754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2009
   4. ASTM D 2244 – Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates; 2011
C. LEED – Leadership in Energy and Environmental Design
D. NAAMM – National Association of Architectural Metal Manufacturers
E. SMACNA – Sheet Metal and Air Conditioning Contractor’s National Association
F. PS - Voluntary Product Standard; National Institute of Standards and Technology (NIST)
   1. PS-1 – Structural Plywood; 2007

METAL PANEL RAINSCREEN
074213 - 1
1.5 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate panel assemblies with rain drainage, flashing, trim, stud back-up, soffits, and other adjoining work.
B. Preinstallation Meeting:
   1. Attendees:
      a. Owner.
      b. Architect.
      c. Installer.
      d. Panel manufacturer's representative.
      e. Structural support installer’s.
      f. Installer’s whose work interfaces with or affects wall panels including installers of doors, windows, and louvers.
   2. Review and finalize construction schedule.
   3. Verify availability of materials, installer's personnel, equipment, and facilities needed to maintain schedule.
   4. Review means and methods related to installation, including manufacturer's written instructions.
   5. Examine support conditions for compliance with requirements, including alignment and attachment to structural members.
   6. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affects this Work.
   7. Review temporary protection requirements for during and after installation of this Work.

1.6 SUBMITTALS
A. See Section 01 3000 – Administrative Requirements, for submittal procedures.
B. Product Data: Submit for each type of product indicated, include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal plate wall panel and accessory.
C. Shop Drawings: Submit fabrication and installation layouts of metal plate wall panels; including details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   1. Provide distinction between factory-assembled, shop-assembled, and field-assembled work.
   2. Provide details of following items at full scale.
      a. Manufacturer’s standard sheet metal trims.
      b. Components of wall panel construction, anchorage methods, and hardware.
D. Coordination Drawings: Submit exterior elevations, drawn to scale, that have the following items shown and coordinated with each other, using input from installers of these items as follows:
   1. Metal plate wall panels and attachments.
   2. Girts.
   3. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
   4. Penetrations of wall by pipes and utilities.
E. Samples: Submit for each type of exposed finish required, and prepared on samples of size as follows:
   1. Decorative Aluminum Metal Plate Wall Panels: At least 2 inch by 3 inch.
F. Test and Inspection Reports: Submit test and inspection reports on each type of wall panel system provided for project based on evaluation of comprehensive tests performed by qualified testing agency.
G. Maintenance Data: Submit maintenance data for metal plate wall panels.
H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
I. Sustainable Design Submittals [LEED Reports]:
   1. Submit documentation from manufacturer for amounts of pre-consumer and post-consumer recycled content for products specified, and include statement indicating costs for materials having recycled content.
   2. Submit documentation providing location of manufacturing.

1.7 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with at least five years of documented experience.
B. Installer: Company specializing in performing work of this section and approved by manufacturer.
   1. Install system in strict compliance with manufacturer's installation instructions.
C. Source Limitations: Obtain each type of metal plate wall panel from single source and from single manufacturer.
1.8 MOCKUPS
   A. Mockups: Provide mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and to establish quality standards for fabrication and installation.
      1. Build mockup of typical wall panel assembly as shown on Drawings, including corner, supports, attachments, and accessories.
         a. Include at least four panels to represent a four-way panel joint and showing full thickness.
      2. Water Spray Test: Conduct water-spray test of mockup metal panel assembly, test water penetration in accordance with AAMA 501.2.
      3. Approval of mockups does not constitute approval of deviation from Contract Documents within mockups unless these deviations are approved by Architect in writing.
      4. Subject to compliance with requirements, approved mockups [may] or [may not] become part of completed Work if undisturbed upon date of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
   B. Storage and Handling: Store materials in clean, dry, interior area in accordance with manufacturer’s instructions.
   C. Deliver panels, components, and other manufactured items without damage or deformation.
   D. Protect panels during transportation, handling, and installation from weather, excessive temperatures and construction operations.
   E. Handle panels in strict compliance with manufacturer’s instructions and recommendations, and in a manner to prevent bending, warping, twisting, and surface damage.
      1. Store panels vertically with top of panel down, storage of panels horizontally is not permitted.
   F. Store panels covered with suitable weather tight and ventilated covering.
   G. Provide storage of panels to ensure dryness, with positive slope for drainage of moisture.
   H. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.
   I. Remove strippable protective covering from aluminum panel prior to installation.

1.10 SITE CONDITIONS
   A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of this Work to be performed according to manufacturer’s installation instructions and warranty requirements.
   B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before panel fabrication and indicate measurements on Shop Drawings. Coordinate with construction schedule.

1.11 WARRANTY
   A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
   B. Wall System Warranty: Provide wall panel manufacturer warranty, agreeing to correct defects in manufacturing of materials within a one year period after date of Substantial Completion.
      1. Failures include, but are not limited to, the following:
         a. Structural failures, including rupturing, cracking, or puncturing.
         b. Deterioration: Beyond normal weathering of wall system metals and other materials.
   C. Panel Finish Warranty: Provide panel finish manufacturer warranty, agreeing to repair finish of metal plate wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
      1. Finish Warranty Period: 20 years from date of Substantial Completion.
      2. Warranty Coverage: In accordance with AAMA 2605 aluminum finish requirements.
         a. Fading, Loss of Color Retention: Loss of 5 Delta E units (Hunter) or less in accordance with ASTM D 2244.
         b. Chalking, Chalky White Powder on Panel Surface: Chalking at No. 8 or less for colors or No. 6 for white in accordance with ASTM D 4214.
         c. Loss of Adhesion: Loss of 10 percent due to cracking, checking or peeling, or failure to adhere to bare metal.
         d. Gloss Retention: 50 percent or less in accordance with ASTM D 523.
         e. Salt Spray, Accelerated: At least 4,000 hours in accordance with ASTM B 117.
         f. Humidity Testing, Accelerated: At least 4,000 hours in accordance with ASTM D 2247.
PART 2 - PRODUCTS

2.1 MANUFACTURER
A. Dri-Design - Wall Panel System: Decorative Coated Aluminum Finish.
   1. Address: 12480 Superior Ct., Holland, Michigan 49424.
   2. P.O. Box 1286 Holland, Michigan 49422-1286.
   3. Phone: (616) 355-2970; Fax: (616) 355-2972; Website: www.dri-design.com.

2.2 PERFORMANCE REQUIREMENTS
A. Metal Plate Wall Panel Assemblies: Comply with performance requirements without failure due to defective manufacturing, fabrication, installation, or other construction defects.
   1. Pressure Equalization Cycling: Pass cycled pressure loading from 5 psf to 25 psf for 100 three-second cycles at 0.08 seconds or less; ASTM E 1233.
   2. Air Infiltration: 0.12 cfm per sf of wall area, tested at 1.57 psf (25 mph) in accordance with ASTM E 283.
      a. Maintain air/water barrier leakage rate at 0.11 to 0.13 cfm per sf at 1.57 psf when tested in accordance with ASTM E 283 in compliance with AAMA 508 criteria.
   3. Water Penetration:
      a. Static: Pass water penetration test under static pressure when tested in accordance with ASTM E 331 at a differential of 10 percent of inward acting design load, with 15 psf pressure differences for at least 15 minutes with 5 gal per sf per hour of water applied.
   4. Structural: Provide systems tested in accordance with ASTM E 330 and certified to be without permanent deformation or failure of structural members.

2.3 MATERIALS
A. Aluminum Plate: Alloy and temper as recommended by manufacturer for application and in compliance with manufacturers design requirements.
   2. Thickness: 0.080 inch.
   3. Weight: Less than 2 lbs per sf.
B. Panel Depth: 1 1/4 inch, nominal.
C. Panel Size: As indicated on Drawings.
D. Panel Joints: As indicated on Drawings.

2.4 FABRICATION
A. Fabricate and finish wall panels within manufacturer’s facilities and fulfill indicated performance requirements demonstrated by laboratory testing.
   1. Comply with indicated profiles and with dimensional and structural requirements.

2.5 FINISHES
A. Comply with NAAMM’s - Metal Finishes Manual for Architectural and Metal Products, for recommendations of designating finishes.
B. Superior Performance Organic Decorative Coating System: AAMA 2605 multiple coat, ambient cured solvent soluble flouropolymer that contains 100 percent fluorinated ethylene vinyl ether (FEVE) resin for base, color and clear top coatings with decorative offset reveal printing system, and chromate primer on back of panel.
   1. FEVE Coating: Lumiflon from Asahi Glass, solvent grade part of LF-500 group, applied to aluminum plate providing a variety of colors in high gloss finish, and resistance to color fading, chalking, and ultra-violet (UV) light. Prepare, pre-treat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer’s installation instructions.
      a. Metal panel Rainscreen Color: Custom color as selected by architect.
C. Field Touch-Up Materials: As recommended by coating manufacturer for field application.
2.6 ACCESSORIES

A. Metal Plate Wall Panel Accessories: Provide components required for a complete metal plate wall panel assembly including trim, copings, fascia, mullions, sills, corner units, flashings, and similar items. Match material and finish of panels unless otherwise indicated.

B. Provide integral drainage system and manufactures standard extrusions at termination of dissimilar materials.

C. Flashing and Trim: Match material, finish, and color of adjacent wall panels.
   1. Thickness: At least 0.040 inch.
   2. Refer to Section 07 6200.

D. Panel Fasteners: Designed to withstand design loads, with at least 7/16 inch diameter head and neoprene washer.

E. Specifier Note: Verify that panel substrates are at least 5/8 inch thick exterior plywood, if not; select from following sub-girts in compliance with project requirements, edit as necessary.

F. Sub-Girts: Galvanized, provide size and gage in accordance with project requirements.
   1. Furring Channel: Provide Hat, C, U or Z type as recommended by manufacturer.
   2. Flat Strap: At least 14 gage thick.
   3. Refer to Section 05 4000.

G. Substrate Wall Sheathing: Plywood, PS 1, Grade C-D, Exposure I, at least 5/8 inch thick.
   1. Refer to Drawings and Section 06 1000 for requirements.

H. Weather Barriers: Provide climate specific weather barrier with performance characteristics for air penetration, water vapor transmission, and water penetration resistance.
   1. Refer to Section 072726 for requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine wall framing to verify that girts, angles, channels, studs, and other structural wall panel support members and anchorage have been installed within alignment tolerances required by wall panel manufacturer.

C. Verify that weather barrier has been installed over sheathing or substrate to prevent air infiltration or water penetration.

D. Examine rough-in for components and systems penetrating wall panels to coordinate actual penetration locations relative to wall panel joint locations prior to installation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Framing: Install sub girt, base angles, sills, furring, and other wall panel support members and provide anchorage in accordance with ASTM C 754 for gypsum panel type substrates and panel manufacturer's installation instructions.

3.3 INSTALLATION

A. Install wall panels in accordance with manufacturer's installation instructions, including pressure equalized rainscreen installation method and installation guidelines.
   1. Wall panels consist of single sheets of metal formed with interlocking gutter and drainage system integral to the panel with single horizontal attachment for dry-joint rainscreen assembly.
   2. Use of secondary drainage channels, brackets, support pins, joint sealants or gaskets to manage the drainage of wall panel system is not permitted.
   3. Attach wall panels using progressive interlocking method, engaging bottom of panel in top of previous panel working bottom up, and left to right.
   4. Install wall panels with single top attachment in pre-punched holes to allow individual panels to move due to thermal expansion.
   5. Do not compromise internal gutter.

B. Install wall panels for orientation, sizes, and locations as indicated on Drawings.

C. Install wall panels with proper anchorage and other components for this Work securely in place.

D. Install wall panels with provisions for thermal and structural movement.

E. Install shims to plumb substrates as necessary for installation of wall panels.

F. Install weather tight seals at perimeter of wall panel openings.
1. Test for proper adhesion on small unexposed area of solid surfacing prior to use.
2. Refer to Section 07 9005.

1. Provide concealed fasteners where possible, and set units true to line and level as indicated.
2. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
3. Install flashing and trim as wall panel Work proceeds.

H. Install weather tight escutcheons for pipe and conduit penetrating exterior walls.

I. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by wall panel manufacturer.

J. Install attachment system to support wall panels and with provisions to provide a complete weather tight wall system, including sub girts, extrusions, flashings and trim.
1. Include attachment to supports and trims at locations using dissimilar materials.
2. Do not apply sealants to joints, unless noted otherwise on Drawings or Shop Drawings.
3. Install starter extrusion at base course and at cut panel locations.

K. Install accessories with positive anchorage to building and weather tight mounting and provisions for thermal expansion, and coordinate installation with flashings and other components.
1. Install components required for a complete wall panel assembly including trim, copings, flashings and other accessory items.

L. Weather Barrier: Install weather barrier behind wall panels and over substrate in accordance with requirements of Section 07 2500.

3.4 TOLERANCES
A. Shim and align wall panel units with installed tolerances of 1/4 inch in 20 feet, non-cumulative, on level, plumb, and location lines as indicated.

3.5 FIELD QUALITY CONTROL
A. Testing Agency: [Owner will engage] or [Engage] a qualified independent testing agency to perform field tests and inspections.
B. Water-Spray Test: After installation and in coordination with Mockup requirements, test area of assembly [shown on Drawings] [as directed by Architect] or <Insert area> for water penetration in accordance with AAMA 501.2.
C. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.
D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
E. Perform additional tests and inspections, at Contractor’s expense, to verify compliance of replaced wall panels or necessary additional work with specified requirements.
F. Prepare test and inspection reports.

3.6 CLEANING
A. Upon completion of wall panel installation, clean finished surfaces as recommended by panel manufacturer.
B. Upon completion of wall panel installation, clear weep holes and drainage channels of obstructions and dirt.

3.7 PROTECTION
A. Protect installed products from damage during subsequent construction.
B. Replace wall panels damaged or deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION
SECTION 075423
THERMOPLASTIC POLYOLEFIN ROOFING

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. Adhered thermoplastic polyolefin (TPO) roofing system.
2. Roof insulation.

1.3 DEFINITIONS
A. Roofing Terminology: Definitions in ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.4 PREINSTALLATION MEETINGS
A. Preinstallation Roofing Conference: Conduct conference at
1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:
1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of roofing, fastening spacings, and patterns for mechanically fastened roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
C. Samples for Verification: For the following products:
1. Sheet roofing, of color required.
2. Walkway pads or rolls, of color required.

1.6 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer and manufacturer.
B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
1. Submit evidence of compliance with performance requirements.
C. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.
D. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
E. Field quality-control reports.
F. Sample Warranties: For manufacturer's special warranties.

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

1.8 QUALITY ASSURANCE
A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for roofing system identical to that used for this Project.
B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
1. Special warranty includes roofing, base flashings, roof insulation, cover boards, and other components of roofing system.
2. Warranty Period: 15 years from date of Substantial Completion, NDL (No Dollar Limit).
B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders and walkway products, for the following warranty period:
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carlisle SynTec Incorporated.
2. Firestone Building Products.
3. GAF Materials Corporation.
5. Johns Manville.
6. Mule-Hide Products Co., Inc.
7. Versico Incorporated.
B. Source Limitations: Obtain components including roof insulation for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.2 PERFORMANCE REQUIREMENTS
A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
1. Corner Uplift Pressure: Refer to structural drawings.
2. Perimeter Uplift Pressure: Refer to structural drawings.
3. Field-of-Roof Uplift Pressure: Refer to structural drawings.
4. Fire/Windstorm Classification: Class 1A-105.
5. Hail Resistance Rating: SH in accordance with requirements in FM Approvals 4450 and FM Approvals 4470.
6. Insulation R-Value: Insulation system shall maintain a minimum R-30 (continuous) Long Term Thermal Resistance (LTIR) as determined in accordance with CAN/ULC-S770, and approved ComCheck.
D. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
E. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.3 TPO ROOFING
1. Thickness: 60 mils nominal.
2. Exposed Face Color: White.

2.4 AUXILIARY ROOFING MATERIALS
A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
1. Liquid-type auxiliary materials shall comply with VOC limits of local authority having jurisdiction.
B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils thick, minimum, of same color as TPO sheet.
C. Bonding Adhesive: Manufacturer's standard.
D. Slip Sheet: Manufacturer's standard, of thickness required for application.
E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
F. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.
G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.
H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.5 ROOF INSULATION
A. General: Preformed roof insulation boards manufactured or approved by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application.
B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Carlisle SynTec Incorporated.
      c. Dyplast Products.
      d. Firestone Building Products.
      e. GAF Materials Corporation.
      f. Hunter Panels.
      g. Insulfoam LLC; a Carlisle company.
      h. Johns Manville.
      i. Rmax, Inc.
   2. Thickness or R Value: Insulation system shall have a minimum R-30 (continuous insulation) Long Term Thermal Resistance (LTTR) value as determined in accordance with CAN/ULC-S770 and the corresponding thickness required to meet this minimum requirement.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES
A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
C. Insulation Adhesive: Insulation manufacturer’s recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
   1. Full-spread spray-applied, low-rise, two-component urethane adhesive.
D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick, factory primed.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corporation; GlasRoc Sheathing GlasRoc Sheathing Type X.
      b. Georgia-Pacific Corporation; Dens Deck Dens Deck DuraGuard Dens Deck Prime.
      c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
      d. Temple-Inland, Inc; GreenGlass Exterior Sheathing.
      e. USG Corporation; Securock Glass Mat Roof Board.

2.7 WALKWAYS
A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads, approximately 3/16 inch thick and acceptable to roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
   1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
   2. Verify that wood blocking and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 “Steel Decking.”
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer’s written instructions. Remove sharp projections.
B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
C. Install insulation strips according to acoustical roof deck manufacturer's written instructions.

3.3 ROOFING INSTALLATION, GENERAL
A. Install roofing system according to roofing system manufacturer's written instructions.
B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
C. Install roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition.

3.4 INSULATION INSTALLATION
A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
C. Install tapered insulation under area of roofing to conform to slopes indicated.
D. Install insulation under area of roofing to achieve required thickness to achieve specified thermal performance requirement in “Performance Requirements”.
1. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
G. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
1. Fasten insulation to resist submitted uplift pressure at corners, perimeter, and field of roof.
H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and fasten to roof deck.
1. Fasten cover boards to resist submitted uplift pressure at corners, perimeter, and field of roof.

3.5 ADHERED ROOFING INSTALLATION
A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.
B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
C. Accurately align roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
D. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.
E. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.
F. Apply roofing with side laps shingled with slope of roof deck where possible.
G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.
1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.
H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.6 BASE FLASHING INSTALLATION
A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.
B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.7 WALKWAY INSTALLATION
A. Flexible Walkways: Install walkway products in locations indicated on Drawings. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.8 FIELD QUALITY CONTROL
A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
C. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.9 PROTECTING AND CLEANING
A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.10 ROOFING INSTALLER'S WARRANTY
A. WHEREAS _______________________________ of ___________________________, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
   1. Owner: .
   2. Address: .
   3. Building Name/Type: .
   4. Address: .
   5. Area of Work: .
   6. Acceptance Date: _________________.
   8. Expiration Date: __________________.
B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense (with "no dollar limit – NDL), make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
D. This Warranty is made subject to the following terms and conditions:
   1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
      a. lightning;
      b. peak gust wind speed exceeding 110 mph;
      c. fire;
      d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
      e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
      f. vapor condensation on bottom of roofing; and
      g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.

3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.

4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.

7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this ___________ day of ________________, ________________.

1. Authorized Signature: _______________________________________.
2. Name: _______________________________________.
3. Title: _______________________________________.

END OF SECTION 075423
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. Formed roof-drainage sheet metal fabrications.
   2. Formed low-slope roof sheet metal fabrications.

1.3 COORDINATION
A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
B. Shop Drawings: For sheet metal flashing and trim.
   1. Include plans, elevations, sections, and attachment details.
   2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
   3. Include identification of material, thickness, weight, and finish for each item and location in Project.
   4. Include details for forming, including profiles, shapes, seams, and dimensions.
   5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   6. Include details of termination points and assemblies.
   7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
   8. Include details of roof-penetration flashing.
   9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
   10. Include details of special conditions.
   11. Include details of connections to adjoining work.
   12. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.
C. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

1.5 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of coping and roof edge flashing that is SPRI ES-1 tested FM Approvals approved.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.
1.7 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.

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

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

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 coating designation; prepainted by coil-coating process to comply with ASTM A 755/A 755M.

1. Surface: Smooth, flat.

2. Exposed Coil-Coated Finish:
   a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: Refer to schedule on Drawings.

4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30-40 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Henry Company; Blueskin PE200 HT.
   b. Carlisle Coatings & Waterproofing Inc., Div. of Carlisle Companies Inc.; CCW WIP 300HT.


3. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.
2.4 MISCELLANEOUS MATERIALS
A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
      b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
      c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
   2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.
C. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

2.5 FABRICATION, GENERAL
A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
   1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
   2. Obtain field measurements for accurate fit before shop fabrication.
   3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
   4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
   1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
   2. Use lapped expansion joints only where indicated on Drawings.
E. Sealant Joints: Where movable, non-expansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
H. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF DRAINAGE SHEET METAL FABRICATIONS
A. Downspouts: Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
   1. Fabricated Hanger Style: SMACNA figure designation: As indicated.
   2. Hanger Style: As indicated.
   3. Fabricate from the following materials:
      a. Prefinished Aluminum
B. Parapet Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fabricate from the following materials:
   1. Prefinished Aluminum
C. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes, exterior flange trim, and built-in overflows. Fabricate from the following materials:
   1. Prefinished Aluminum.

D. Splash Blocks: Refer to Division 32 section “Precast Concrete Site Accessories”.

2.7 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Built-in Gutters: Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in minimum 96-inch-long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
   1. Fabricate gutters with built-in expansion joints and gutter-end expansion joints at walls.
   2. Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.
   3. Fabricate from the Following Materials:
      a. Stainless Steel: 0.016 inch thick.

2.8 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing: Fabricate in minimum 96-inch-long, but not exceeding 12-foot-long sections. Furnish with 6-inch-wide, joint cover plates. Shop fabricate interior and exterior corners.
   1. Joint Style: Butted with expansion space and 6-inch-wide, concealed backup plate.
   2. Fabricate from the Following Materials:
      a. Galvanized Steel: 0.028 inch thick.

B. Base Flashing: Fabricate from the following materials:
   1. Galvanized Steel: 0.028 inch thick.

C. Counterflashing: Fabricate from the following materials:
   1. Galvanized Steel: 0.022 inch thick.

D. Flashing Receivers: Fabricate from the following materials:
   1. Galvanized Steel: 0.022 inch thick.

E. Roof-Penetration Flashing: Fabricate from the following materials:
   1. Galvanized Steel: 0.028 inch thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:
   1. Galvanized Steel: 0.028 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

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

3.2 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days of its insulation.
3.3 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
5. Torch cutting of sheet metal flashing and trim is not permitted.
6. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.

3.4 ROOF-DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Built-in Gutters: Join sections with riveted and soldered joints or joints sealed with sealant. Provide for thermal expansion. Slope to downspouts. Provide end closures and seal watertight with sealant.

1. Install underlayment layer in built-in gutter trough and extend to drip edge at eaves and underlayment on roof sheathing. Lap sides minimum of 2 inches over underlying course. Lap ends minimum of 4 inches. Stagger end laps between succeeding courses at least 72 inches. Fasten with roofing nails. Install slip sheet over underlayment.
2. Anchor and loosely lock back edge of gutter to continuous cleat.
3. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 18 inches apart.
4. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.

3.5 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
C. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.
D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches. Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant unless otherwise indicated.
F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 ERECTION TOLERANCES
A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.7 CLEANING AND PROTECTION
A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
B. Clean off excess sealants.
C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION
SECTION 076210
FLEXIBLE FLASHING

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. Formed Products: Concealed flashing within wall assemblies to protect and shed incidental water to the exterior.

1.3 PERFORMANCE REQUIREMENTS
A. General: Flashing and trim assemblies as indicated shall withstand structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Do not store flashing materials in contact with other materials that might cause staining, denting, or other surface damage. Store flashing materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

PART 2 - PRODUCTS

2.1 FLEXIBLE FLASHING
A. Self-Adhesive flexible flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 40 mils.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Advanced Building Products Inc.; Strip-N-Flash.
      b. Carlisle Coatings & Waterproofing; CCW-705 Air & Vapor Barrier Strips.
      c. Grace Construction Products; Perm-A-Barrier Detail Membrane.
      d. Henry; Blueskin SA

2.2 HIGH TEMPERATURE FLASHING
A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with releasepaper backing; cold applied. Provide primer when recommended by manufacturer.
   2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.
   3. Products: Subject to compliance with requirements, provide one of the following:
      a. Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT.
c. Henry Company; Blueskin PE200 HT.
d. Owens Corning; WeatherLock Metal High Temperature Underlayment.

2.3 MISCELLANEOUS MATERIALS
A. General: Provide materials and types of fasteners, separators, sealants, and other miscellaneous items as required for complete metal flashing installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
B. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.
   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FLASHING INSTALLATION
A. General: Install as indicated on Drawings and per Manufacturer’s recommendations.
B. Self-Adhering Sheet Flashing: Install self-adhering sheet flashing, wrinkle free. Apply primer if required by flashing manufacturer. Comply with temperature restrictions of flashing manufacturer for installation. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover flashing with subsequent construction within 14 days of material insulation.
C. Location:
   1. Flexible Flashing: As indicated on drawings, or at all exterior windows, doors or other penetrations where high temperature flashing is not required.
   2. High Temperature Flashing: As indicated on drawings, or at all locations where flashing will be in contact with metal coping or metal panels where high temperatures exist.

END OF SECTION
SECTION 077100
ROOF 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.
B. Related Work:
   1. Section 074113 “Metal Roof Panels” for flashing and trim at standing seam metal roof.

1.2 SUMMARY
A. Section Includes:
   1. Roof-edge specialties.
   2. Reglets and counterflashings.
B. Preinstallation Conference: Conduct conference at Project site
   1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
   2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
   3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: For roof specialties.
   1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work.
   2. Distinguish between plant- and field-assembled work.
   3. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
   4. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
   5. Detail termination points and assemblies, including fixed points.
   6. Include details of special conditions.
C. Samples: For each type of roof specialty and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of roof specialty.

1.5 QUALITY ASSURANCE
A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and set quality standards for fabrication and installation.
   1. Build mockup of typical reglets and counterflashings as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Do not store material in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.
1.7 FIELD CONDITIONS
A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.8 WARRANTY
A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Roofing Section.
B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 ROOF-EDGE SPECIALTIES
A. Formed Aluminum Sheet Fascia Covers: Aluminum sheet, 0.050 inch (1.27 mm) thick.
   1. Surface: Smooth, flat finish.
   2. Finish: Two-coat fluoropolymer.
   4. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.
   5. Receiver: Manufacturer's standard material and thickness.
   7. Fascia Accessories: Spillout scuppers.

2.3 REGLETS AND COUNTERFLASHINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Castle Metal Products.
   2. Cheney Flashing Company.
   3. Fry Reglet Corporation.
   4. Heckmann Building Products Inc.
   5. Hickman Company, W. P.
   7. Metal-Era, Inc.
   8. Metal-Fab Manufacturing, LLC.
B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
   1. Zinc-Coated Steel: Nominal (uncoated) 0.0359-inch thickness.
   2. Corners: Factory mitered and mechanically clinched and sealed watertight.
   3. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   4. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 12 feet designed to snap into reglets and compress against base flashings with joints lapped, from the following exposed metal:
   1. Zinc-Coated Steel: Nominal (uncoated) 0.0209-inch thickness.

D. Accessories:
   1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
   2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

E. Zinc-Coated Steel Finish: Two-coat fluoropolymer.
   1. Color: As indicated.

2.4 MATERIALS
A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation.

2.5 MISCELLANEOUS MATERIALS
A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
   1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
   2. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
   3. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
B. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
C. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.
D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.6 FINISHES
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Appearance of Finished Work: 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.
D. Coil-Coated Galvanized-Steel Sheet Finishes:
   1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with ASTM A 755/A 755M and coating and resin manufacturers' written instructions.
      a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      b. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
E. Coil-Coated Aluminum Sheet Finishes:
   1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
B. Examine walls and parapets for suitable conditions for roof specialties.
C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL
A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
   1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
   2. Provide uniform, neat seams with minimum exposure of solder and sealant.
   3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
   4. Torch cutting of roof specialties is not permitted.
   5. Do not use graphite pencils to mark metal surfaces.
B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   1. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
   1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
   2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
D. Fastener Sizes: Use fasteners of sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint install sealants at temperatures below 40 deg F.

3.3 INSTALLATION OF ROOF-EDGE SPECIALITIES
A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.4 REGLET AND COUNTERFLASHING INSTALLATION
A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.
B. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches over top edge of base flashings.
C. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.5 CLEANING AND PROTECTION
A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
B. Clean and neutralize flux materials. Clean off excess solder and sealants.
C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.
SECTION 077200
ROOF ACCESSORIES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Roof curbs.
      2. Equipment supports.
      3. Roof hatches.
      4. Pipe supports.

1.3 PERFORMANCE REQUIREMENTS
   A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1.4 SUBMITTALS
   A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   B. Shop Drawings: For roof accessories. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

1.5 COORDINATION
   A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
   B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.6 WARRANTY
   A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
      1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
         a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
         b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
         c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
      2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2. METAL MATERIALS
   A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation and mill phosphatized for field painting where indicated.
      1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
      2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.
   B. Galvanized-Steel Tube: ASTM A 500, round tube, hot-dip galvanized according to ASTM A 123/A 123M.
2.2 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Glass-Fiber Board Insulation: ASTM C 726, thickness as indicated.

C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Underlayment:
   1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
   1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
   2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
   3. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
   4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

H. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

I. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.


2.3 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units with integral spring-type vibration isolators and capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, integral metal cant, and integrally formed deck-mounting flange at perimeter bottom.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Curbs Plus, Inc.
      b. LM Curbs.
      c. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
      d. Pate Company (The).
      e. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: steel sheet, 0.052 inch thick.
   1. Finish: Mill phosphatized.

D. Construction:
   1. Insulation: Factory insulated with 1-1/2-inch-thick glass-fiber board insulation.
   2. Liner: Same material as curb, of manufacturer's standard thickness and finish.
   3. Factory-installed wood nailer at top of curb, continuous around curb perimeter.
   4. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
   5. Top Surface: Level around perimeter with roof slope accommodated by sloping the deck-mounting flange.

2.4 EQUIPMENT SUPPORTS

A. Equipment Supports: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, integral metal cant, and integrally formed deck-mounting flange at perimeter bottom.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Curbs Plus, Inc.
      b. LM Curbs.
      c. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
d. Pate Company (The).
e. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: Steel sheet, 0.052 inch thick.
   1. Finish: Mill phosphatized.

D. Construction:
   1. Insulation: Factory insulated with 1-1/2-inch thick glass-fiber board insulation.
   2. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
   3. Factory-installed continuous wood nailers 3-1/2 inches wide at tops of equipment supports.
   4. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
   5. Fabricate equipment supports to minimum height of 12 inches unless otherwise indicated.

2.5 ROOF HATCH
A. Roof Hatches: Metal roof-hatch units with lids and insulated single-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, integral metal cant, and integrally formed deck-mounting flange at perimeter bottom.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Babcock-Davis.
      b. Bilco Company (The).
      c. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
      d. Nystrom.
      e. O'Keeffe's Inc.

B. Type and Size: Single-leaf lid, refer to Drawings for size.


D. Hatch Material: Zinc-coated (galvanized) steel sheet, 0.079 inch thick.
   1. Finish: Mill phosphatized.

E. Construction:
   1. Insulation: Glass-fiber board.
   2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   3. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
   4. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.

F. Hardware: Stainless-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.

G. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
   1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
   2. Height: 42 inches above finished roof deck.
   5. Finish: Manufacturer's standard baked enamel or powder coat.
      a. Color: As selected by Architect from manufacturer's full range.

2.6 PIPE SUPPORTS
A. Pipe Supports: Adjustable-height, extruded-aluminum tube, filled with urethane insulation; 2 inches in diameter; with aluminum baseplate, EPDM base seal, manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, and extruded-aluminum carrier assemblies; suitable for quantity of pipe runs and sizes.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Thaler Metal USA Inc.
   2. Pipe Support Height: As indicated on Drawings.
   3. Roller Assembly: With stainless-steel roller, sized for supported pipes.
   4. Pipe Support Flashing: Manufacturer's standard insulated sleeve flashing with integral base flange; aluminum sheet, 0.063 inch thick.
   5. Finish: Manufacturer's standard.

2.7 GENERAL FINISH REQUIREMENTS
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations.
for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
C. Verify dimensions of roof openings for roof accessories.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. General: Install roof accessories according to manufacturer’s written instructions.
1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
C. Roof Curb Installation: Install each roof curb so top surface is level.
D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
E. Roof-Hatch Installation:
1. Install roof hatch so top surface of hatch curb is level.
2. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
3. Attach ladder-assist post according to manufacturer’s written instructions.
F. Pipe Support Installation: Install pipe supports so top surfaces are in contact with and provide equally distributed support along length of supported item.
G. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING
A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.
B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
C. Clean exposed surfaces according to manufacturer’s written instructions.
D. Clean off excess sealants.
E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION
SECTION 078413

PENETRATION FIRESTOPPING

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. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS
A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
B. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
   a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
   b. Classification markings on penetration firestopping correspond to designations listed by the following:
      1) UL in its "Fire Resistance Directory."
D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS
A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.
1.7 COORDINATION
A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.
C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Grace Construction Products.
2. Hilti, Inc.
3. RectorSeal Corporation.
4. Specified Technologies Inc.
5. 3M Fire Protection Products.
6. USG Corporation.

2.2 PENETRATION FIRESTOPPING
A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   1. Fire-resistance-rated walls include fire walls fire-barrier walls smoke-barrier walls and fire partitions.
   2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   1. Horizontal assemblies include floors floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
   2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
   3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.
E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the limits for VOC content as indicated in Section 018113:
H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
   1. Permanent forming/damming/backing materials, including the following:
      a. Slag-wool-fiber or rock-wool-fiber insulation.
      b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
      c. Fire-rated form board.
      d. Fillers for sealants.
   2. Temporary forming materials.
   5. Steel sleeves.
2.3 FILL MATERIALS
A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
B. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
C. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
D. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
E. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
F. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
G. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
H. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
I. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING
A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
   1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
   2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.
B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.
3.3 INSTALLATION
A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
C. Install fill materials for firestopping by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION
A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing and inspecting agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

3.5 FIELD QUALITY CONTROL
A. Owner will engage a qualified testing agency to perform tests and inspections.
B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.
C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION
A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SCHEDULE
A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
B. Refer to Drawings for specific scheduled applications.

END OF SECTION
SECTION 078446
FIRE-RESISTIVE JOINT 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. Joints in or between fire-resistance-rated constructions.
2. Joints at exterior curtain-wall/floor intersections.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS
A. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."
B. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistant joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
C. Fire-Test-Response Characteristics: Fire-resistant joint systems shall comply with the following requirements:
1. Fire-resistant joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Fire-resistant joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
   a. Fire-resistant joint system products bear classification marking of qualified testing agency.
   b. Fire-resistant joint systems correspond to those indicated by reference to designations listed by the following:
      1) UL in its "Fire Resistance Directory."
D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS
A. Environmental Limitations: Do not install fire-resistant joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistant joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
B. Install and cure fire-resistant joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION
A. Coordinate construction of joints to ensure that fire-resistant joint systems are installed according to specified requirements.
B. Coordinate sizing of joints to accommodate fire-resistant joint systems.
C. Notify Owner's testing agency at least seven days in advance of fire-resistant joint system installations; confirm dates and times on day preceding each series of installations.
PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistant joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistant joint systems are installed. Fire-resistant joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grace Construction Products.
   2. Hilti, Inc.
   3. RectorSeal Corporation.
   4. Specified Technologies Inc.
   5. 3M Fire Protection Products.
   6. USG Corporation.

C. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistant joint systems with ratings determined per ASTM E 1966 or UL 2079:
   1. Joints include those installed in or between fire-resistance-rated walls floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
   2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.

D. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistant joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg or ASTM E 2307.
   1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

E. Joints in Smoke Barriers: Provide fire-resistant joint systems with ratings determined per UL 2079.
   1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.

F. VOC Content: Fire-resistant joint system sealants shall comply with VOC content requirements of authority having jurisdiction.

G. Accessories: Provide components of fire-resistant joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistant joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistant joint systems to comply with fire-resistant joint system manufacturer's written instructions and the following requirements:
   1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
   2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistant joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistant joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistant joint system's seal with substrates.

3.3 INSTALLATION

A. General: Install fire-resistant joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
   1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
   2. Apply fill materials so they contact and adhere to substrates formed by joints.
   3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION
A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

3.5 FIELD QUALITY CONTROL
A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.
C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING
A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.
B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.7 FIRE-RESISTIVE JOINT SYSTEM SCHEDULE
A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.
B. Refer to Drawings for specific scheduled applications.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Nonstaining silicone joint sealants.
   2. Urethane joint sealants.
   3. Mildew-resistant joint sealants.
   4. Butyl joint sealants.
   5. Latex joint sealants.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS
A. Product Data: For each joint-sealant product.
B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
C. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.

1.5 INFORMATIONAL SUBMITTALS
A. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer.
B. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
C. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
D. Field-Adhesion-Test Reports: For each sealant application tested.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
B. Product Testing: Test joint sealants using a qualified testing agency.
   1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.
C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.
1.7  PRECONSTRUCTION TESTING  
A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.  
   2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.  
   3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with stone substrates.  
   4. Submit manufacturer’s recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.  
   5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.  
   6. For materials failing tests, obtain joint-sealant manufacturer’s written instructions for corrective measures, including use of specially formulated primers.  
   7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.
B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
   1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.  
   2. Conduct field tests for each kind of sealant and joint substrate.  
   3. Notify Architect seven days in advance of dates and times when test joints will be erected.  
   4. Arrange for tests to take place with joint-sealant manufacturer’s technical representative present.  
         1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.  
   5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.  
   6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.8  FIELD CONDITIONS  
A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.  
   2. When joint substrates are wet.  
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.  
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.  

1.9  WARRANTY  
A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.  
   1. Warranty Period: Two years from date of Substantial Completion.  
B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.  
   1. Warranty Period: Five years from date of Substantial Completion.  
C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.  
   2. Disintegration of joint substrates from causes exceeding design specifications.  
   3. Mechanical damage caused by individuals, tools, or other outside agents.  
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.
PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL
A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the requirements of authorities having jurisdiction.
C. Colors of Exposed Joint Sealants: As indicated.

2.2 NONSTAINING SILICONE JOINT SEALANTS
A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.
B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Corning Corporation; 795.
   b. GE Construction Sealants; SilPruf NB.
   c. Pecora Corporation; 864NST.
   d. Tremco Incorporated; Spectrem 2.
   e. Sika Corporation; Sikasil W S295.

2.3 URETHANE JOINT SEALANTS
A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. BASF Construction Chemicals, LLC, Building Systems; Masterseal TX1.
   b. Pecora Corporation; Dynatrol I-XL.
   c. Sherwin-Williams Company (The); Stampede-1.
   d. Tremco Incorporated; Dymonic.
   e. Sika Corporation; Sikaflex 2c NS.
B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. BASF Construction Chemicals, LLC, Building Systems; Sonolastic SL 1.
   b. Pecora Corporation; NR-201.
   c. Sherwin-Williams Company (The); Stampede 1SL.
   d. Sika Corporation; Sikaflex 2c SL.
C. Urethane, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 25, Uses T and NT.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Bostik, Inc.; Chem-Calk 955-SL.
   b. Pecora Corporation; Dynatrol II SG
   c. Sherwin-Williams Company (The); Stampede-2SL.
   d. Tremco Incorporated; THC 900/901.
   e. Sika Corporation; Sika Sikaflex 2C SL.

2.4 MILDEW-RESISTANT JOINT SEALANTS
A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Corning Corporation; 786-M White.
   b. GE Construction Sealants; SCS1700 Sanitary.
   c. Tremco Incorporated; Tremseal 200.
   d. Sika Corporation; Sikasil GP.
2.5 BUTYL JOINT SEALANTS
   A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.
      1. Products: Subject to compliance with requirements, provide one of the following:
         b. Pecora Corporation; BC-158.

2.6 LATEX JOINT SEALANTS
   A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
      1. Products: Subject to compliance with requirements, provide one of the following:
         a. BASF Construction Chemicals, LLC, Building Systems; Sonolac.
         b. Pecora Corporation; AC-20.
         c. Sherwin-Williams Company (The); 850A.
         d. Tremco Incorporated; Tremflex 834.

2.7 JOINT-SEALANT BACKING
   A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and
      other joint fillers; and approved for applications indicated by sealant manufacturer based on field
      experience and laboratory testing.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. BASF Construction Chemicals, LLC, Building Systems.
         b. Construction Foam Products, a division of Nomaco, Inc.
   B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size
      and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
   C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for
      preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint.
      Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS
   A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to
      joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
   B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant
      backing materials, free of oily residues or other substances capable of staining or harming joint substrates
      and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to
      joint substrates.
   C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to
      joints.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements
      for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-
      sealant manufacturer's written instructions and the following requirements:
      1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant,
         including dust, paints (except for permanent, protective coatings tested and approved for sealant
         adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing,
         water repellents, water, surface dirt, and frost.
      2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination
         of these methods to produce a clean, sound substrate capable of developing optimum bond with
         joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or
         blowing out joints with oil-free compressed air. Porous joint substrates include the following:
         a. Concrete.
         b. Masonry.
         c. Unglazed surfaces of ceramic tile.
         d. Stucco.
      3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS
A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.4 FIELD QUALITY CONTROL
A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed and cured sealant joints as follows:
      a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
      b. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.
      a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
   3. Inspect tested joints and report on the following:
      a. Whether sealants filled joint cavities and are free of voids.
      b. Whether sealant dimensions and configurations comply with specified requirements.
c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING
A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION
A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE
A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
1. Joint Locations:
   a. Isolation and contraction joints in cast-in-place concrete slabs.
   b. Joints between different materials listed above.
   c. Other joints as indicated on Drawings.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
1. Joint Locations:
   b. Joints between plant-precast architectural concrete units.
   c. Control and expansion joints in unit masonry.
   d. Joints in dimension stone cladding.
   e. Joints in exterior insulation and finish systems.
   f. Joints between different materials listed above.
   g. Perimeter joints between materials listed above and frames of doors, windows and louvers.
   h. Other joints as indicated on Drawings.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
1. Joint Locations:
   b. Control and expansion joints in stone flooring.
   c. Control and expansion joints in tile flooring.
   d. Other joints as indicated on Drawings.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
1. Joint Locations:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Tile control and expansion joints.
   c. Vertical joints on exposed surfaces of unit masonry, walls and partitions.
   d. Other joints as indicated on Drawings.
2. Joint Sealant: Urethane, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
1. Joint Locations:
   a. Control joints on exposed interior surfaces of exterior walls.
   b. Perimeter joints between interior wall surfaces and frames of interior doors, windows
   c. Other joints as indicated on Drawings.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Tile control and expansion joints where indicated.
   c. Other joints as indicated on Drawings.
2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

G. Joint-Sealant Application: Concealed mastics.
1. Joint Locations:
   a. Aluminum thresholds.
   b. Sill plates.
   c. Other joints as indicated on Drawings.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION
SECTION 08113
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Building Envelope Requirements

1.2 SUMMARY
A. Section Includes:
   1. Standard hollow metal doors and frames.
B. Related Sections:
   1. Division 04 Section “Unit Masonry” for embedding anchors for hollow metal work into masonry construction.
   2. Division 08 Section “Flush Wood Doors” for wood doors in hollow metal frames.
   3. Division 08 Section for door hardware for hollow metal doors.
   4. Division 09 Section “Exterior Painting” and “Interior Painting” for field painting hollow metal doors and frames.
   5. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 DEFINITIONS
A. Minimum Thickness: Minimum thickness of base metal without coatings.
B. Standard Hollow Metal Work to comply with the following Steel Door Institute Performance Standards:
   1. Hollow metal work fabricated according to ANSI/SDI A250.8 (R2008).
   3. ANSI/SDI A250.6 (R2009) - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.
B. Sustainable Submittals:
C. Provide product cost and pre-and post-consumer recycled content.
D. Shop Drawings: Include the following:
   1. Elevations of each door design.
   2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, joints, field splices, and connections.
   7. Details of accessories.
   8. Details of moldings, removable stops, and glazing.
   9. Details of conduit and preparations for power, signal, and control systems.
E. Other Action Submittals:
1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.
2. Supplier to submit shop drawing schedules with in two weeks of written notification from Contractor in the event to expedite the process of frames to jobsite.
3. Certificate: current certificate stating the manufacturer is a member of SDI.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE
A. Source Limitations: Obtain hollow metal doors and frames from single source manufacturer.
B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 and UL10C, embossed labels are acceptable on standard 3 sided door frames.
   1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   2. Temperature-Rise Limit, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
C. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite.
D. Smoke-Control Door Assemblies: Comply with NFPA 105.
E. Preinstallation Conference: Conduct conference at Project site to review anchor methods, electrical conduit connections and custom installation of unusual openings such as pocket frames, single rabbet double egress frames and recessed doors flush with walls.
F. For Seaward, Inland 1, Inland 2 projects meet the following requirements:
   1. Wind Loads: Provide hollow metal and door hardware assemblies approved by the Texas Department of Insurance or certificate of compliance from independent registered engineer in the state of Texas to include anchorage, capable of withstanding windload, per authorities having jurisdiction and the International Building Code Design Loads per section 1609.
   2. Hurricane-Resistance Test Performance: Provide hollow metal and door hardware approved assemblies that pass large missile-impact tests, as required by 'Texas Department of Insurance systems' location above grade and cyclic-pressure tests according to testing requirements of authorities having jurisdiction.
      a. Impact Resistance: Hollow metal with approved door hardware assemblies must satisfy the Texas Department of Insurance's criteria for protection from windborne debris in both the Inland I zone and the Seaward zone. The assemblies must have passed the large missile impact test (which equates to Missile Level D specified in ASTM E 1996-02). The assemblies may be installed at any height on the structure as long as the design pressure rating for the assemblies is not exceeded. These assemblies will and do not need to be protected with an impact protective system when installed in areas where windborne debris protection is required.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
   1. Provide additional protection to prevent damage to finish of factory-finished units.
B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.
   1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.
   2. Any scratches or disfigurements caused in shipping or handling are promptly cleaned and touched up with a rust-inhibitive primer to new conditions.
1.7 PROJECT CONDITIONS
A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION
A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Manufacturers of current SDI membership:
   1. Ceco Door Products; an Assa Abloy Group company.
   2. Curries Company; an Assa Abloy Group company.
   3. Steelcraft; an Ingersoll-Rand company.
   4. De La Fontaine.

2.2 MATERIALS
A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B; suitable for exposed applications.
B. Hot-Rolled Steel Sheet: ASTM A 1011, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
C. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS), Type B; with minimum G60 Z180 or A60ZF180 metallic coating.
D. Frame Anchors: ASTM A 591, Commercial Steel (CS), 40Z 12G coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008 or ASTM A 1011, hot-dip galvanized according to ASTM A 153, Class B.
E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153.
F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
G. Glazing: Comply with requirements in Division 08 Section "Glazing."

2.3 STANDARD HOLLOW METAL DOORS
A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
   1. Design: Flush panel.
   2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polysocyanurate, mineral-board, or vertical steel-stiffener core.
      a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
      b. Steel-stiffened door at interior and exterior shipping and receiving locations.
      c. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal resistance value (R-value) of not less than 11 when tested to ASTM C518 calculated and 3.0 when tested to ASTM C1363 operable.
         1) Locations: All exterior doors, and as indicated on Door Schedule.
   3. Vertical Edges for Single-Acting Doors:
         1) At meeting edges of pairs of doors bevel edge at active leaf, square edge at inactive leaf.
         2) Universal hinge preps for reverse swinging of doors are not acceptable.
   5. Top and Bottom Edges: Closed with flush or inverted 0.042-inch-thick, end closures or channels of same material as face sheets.
   7. Provide hollow metal doors with at least 30 percent total recycled; 10 percent post-consumer content.
B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush).

C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   1. Level 3 and Physical Performance Level B (Heavy Duty), Model 2 (Full Flush).

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

   1. Fabricate frames with mitered or coped corners.
   2. Fabricate frames as face welded joints and back weld joints continuously, unless otherwise indicated.
   3. Frames for Level 3 Steel Doors: (14 gage) thick steel sheet.

C. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
   1. Fabricate frames with mitered or coped corners.
   2. Fabricate frames as full profile and face welded unless otherwise indicated.
   3. Frames for Level 3 Steel Doors: (16 gage) - thick steel sheet.
   4. Frames 48-inches and wider in opening width are required to meet min. 14 gage thick steel sheet.
   5. Frames for Wood Doors: (16 gage) thick steel sheet.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

E. Knock down frames are not acceptable. Provide knock down, pre-finished frames where indicated.

2.5 FRAME ANCHORS

A. Jamb Anchors:
   1. Masonry Anchors: Frames for installation in masonry walls shall be provided with adjustable jamb anchors of the (T-strap). Anchors shall be not less than 16 gage steel. T-straips shall be not less than 2” X 10” in size, corrugated and/or perforated. The number of anchors provided on each jamb shall be as follows:
      a. Frames up to 60” height: 2 anchors.
      b. Frames greater than 60” up to 90” 3 anchors.
      c. Frames greater than 90” up to 96” 4 anchors.
      d. Frames greater than 96” 4 anchors plus one for each 24” or fraction thereof over 96”, spaced at 24” maximum between anchors.

   2. Stud Anchors: Welded frames for installation in stud partitions shall be provided with welded in steel anchors of suitable design, not less than 18 gage thickness, secured inside each jamb as follows:
      a. Frames up to 60” height: 2 anchors.
      b. Frames greater than 60” up to 90” 4 anchors.
      c. Frames greater than 90” up to 96” 5 anchors.
      d. Frames greater than 96”: 5 anchors plus one for each 24” or fraction thereof over 96” spaced at 24” maximum between anchors.

   3. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location. 3” minimum embedment.


B. Floor Anchors: Formed from same material as frames, not less than 0.067 inch thick, and as follows:
   1. Monolithic Concrete Slabs: Floor anchors shall be provided with two holes for fasteners and shall be fastened inside jambs with at least four (4) spot welds per anchor.
2.6 HOLLOW METAL PANELS
   A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

2.7 STOPS AND MOLDINGS
   A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
   B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.
   C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed. Field cuts are not acceptable.
   D. Cut-off (Sanitary) Stops (for healthcare environments only): Where indicated on door schedule/frame type, terminate stops 6 inches above finish floor with a [45] degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

2.8 LOUVERS
   A. Provide louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.020-inch- thick, cold-rolled steel sheet set into 0.032-inch- thick steel frame.
      1. Sight-Proof Louver: Stationary louvers constructed with inverted V-shaped or Y-shaped blades.
      2. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same testing and inspecting agency that established fire-resistance rating of door assembly.

2.9 ACCESSORIES
   A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
   B. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.10 FABRICATION
   A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
   B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
   C. Hollow Metal Doors:
      1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
      2. Glazed Lites: Factory cut openings in doors.
      3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
      4. Continuous Hinge Reinforcement: Provide continuous 12 gage strap tack welded to door edge for continuous hinges specified in hardware sets in Div. 8 Door hardware, unless door has continuous steel channel for hinge reinforcement.
      5. Electrical Raceways: Provide raceways to accommodate up to twelve (12) wires as required for electrified door hardware specified in hardware sets in Div. 8 Door Hardware.
      6. Seamless Edge (Model 2): Provide seamless edge on hollow metal doors by intermittently tack welding seam, grinding smooth and finishing edge free from defects and blemishes.
   D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
      1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
      2. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
      3. Equal Rabbet Frames: Provide frames with equal rabbet dimensions unless glazing and removable stops require wider dimension on glass side of frame.
      4. Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 42-inch and wider with mortise/butt type hinges at top hinge location to deter against hinge reinforcement sag; required at all openings with automatic openers.
5. Continuous Hinge Reinforcement: Provide continuous 12 gage strap tack welded to frame stop for continuous hinges specified in hardware sets in Div. 8 Door hardware.

6. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

7. Provide A60 Galvannealed coating at frames in restrooms with showers/Jacuzzi, clean areas such as surgery rooms and surgical suites, clean rooms, and soil rooms.

8. Electrical Knock Out Boxes: Factory weld 18 gage electrical knock out boxes to frame for electrical hardware preps; included to electrical thru wire hinges, electrical raceways, door position switches, electric strikes, jamb mount card readers, and magnet locks as noted in door hardware sets in Division 8 Door Hardware.
   a. Electrical knock out boxes are required at door position switches, electric strikes, card readers, and middle hinge locations for all exterior locations regardless of electrical hardware specified in Division 8 Door Hardware.
   b. Provide electrical knock out boxes with a dual 1/2-inch and 3/4-inch knockouts.
   c. Conduit to be factory installed for electric hardware preps. Frames with factory installed conduit to have weld in place anchors.
   d. Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 8 Door Hardware.
   e. Electrical knock out boxes for continuous hinges should be located in the center of the vertical dimension on the hinge jamb, coordinate with hardware supplier.
   f. Provide conduit for standardized plug connectors to accommodate up to (12) wires for electrified door hardware specified in hardware sets in Division 8 Door Hardware.

9. Door Silencers: Exception on weather-stripped or gasketed doors, drill stops to receive door silencers as follows. Keep holes clear during construction. Silencers to be supplied by frame manufacturer regardless if specified in Div. 8 Door Hardware.
   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
   1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
   2. Reinforce doors and frames to receive non-templated, mortised and surface-mounted door hardware.
   3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI 115 Series specifications for preparation of hollow metal work for hardware.
   4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
   1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
   2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
   4. Provide loose stops and moldings on inside of hollow metal work.
   5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.
   6. Gap for butted or mitered joints in glass stop should not exceed .0625-inch.

2.11 STEEL FINISHES
A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
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 embedded and built-in anchors to verify actual locations before frame installation.
C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Remove welded-in shipping spreaders installed at factory after installation of frame in wall. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
   1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jambs perpendicular to frame head.
   2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.
C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION
A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.
B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
   1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      a. At fire-protection-rated openings, install frames according to NFPA 80.
      b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
      c. Install frames with removable glazing stops located on secure side of opening.
      d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
      e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
   2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
      a. Floor anchors may be set with powder-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.
   4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
   5. Field Supplied Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
       In-Place Concrete or Masonry Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   6. In-Place Gypsum Board Partitions: Secure frames in place with post-installed expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
   1. Non-Fire-Rated Standard Steel Doors:
      a. Jambs and Head: 1/8 inch () plus or minus 1/16 inch.
      b. Between Edges of Pairs of Doors: 1/8 inch (plus or minus 1/16 inch.
      c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
   2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
   3. Smoke-Control Doors: Install doors according to NFPA 105.

D. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
   1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.
   2. Secure exterior removable stops with security head stainless steel screws.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Adjust frames and doors per SDI 122 Installation for trouble shooting openings.

C. Remove grout and other bonding material from hollow metal work immediately after installation.

D. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

E. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION
SECTION 081216
ALUMINUM FRAMES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes interior aluminum frames for doors and glazing installed in gypsum board partitions.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, fire-resistance rating, and finishes. Include manufacturer’s printed installation instructions.
B. Shop Drawings: Include the following:
   1. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   2. Locations of reinforcements and preparations for hardware.
   3. Details of each different wall-opening condition.
   4. Details of anchorages, joints, field splices, and connections.
   5. Details of accessories.
   6. Details of removable stops and glazing.
   7. Details of conduits and preparations for power, signal, and control systems.
C. Schedule: For interior aluminum frames. Use same designations indicated on Drawings. Coordinate with door hardware schedule and glazing.
D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of interior aluminum frame.
E. Sustainable Submittal:
   1. Product data products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain interior aluminum frames from single source from single manufacturer.
B. Fire-Rated Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
C. Smoke- and Draft-Control Assemblies: At corridors, smoke barriers, smoke partitions, and elsewhere as indicated, provide assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
   1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.
D. Mockups: Install one frame in scheduled partition for review and acceptance by the Architect.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver interior aluminum frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic. Store interior aluminum frames under cover at Project site.

1.6 WARRANTY
A. Provide warranty against defects in materials for a period of 1 year from date of substantial completion and for 3 years for finishes.
PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Frameworks Manufacturing.
   2. Versatrac.
B. Substitutions in accordance with section 012500 “Substitution Procedures”.

2.2 COMPONENTS
A. Aluminum Framing: ASTM B 221, Alloy 6063-T5 or alloy and temper required to suit structural and finish requirements, not less than 0.062 inch thick. Billets shall be composed of at least 33% recycled aluminum.
B. Door Frames: Extruded aluminum, reinforced for hinges, strikes, and closers. Refer to Drawings for frame types.
   1. 90-Minute Fire-Protection Rating (where indicated in schedule): Fabricate aluminum frame assemblies with a cold-formed, primed, interior steel liner.
C. Glazing Frames: Extruded aluminum, for glazing thickness indicated.
D. Ceiling Tracks: Extruded aluminum.
E. Trim: Extruded aluminum, not less than 0.062 inch thick, with removable snap-in glazing stops and door stops without exposed fasteners.
   1. Trim Style: As selected from Manufacturers full line.

2.3 ACCESSORIES
A. Fasteners: Aluminum, nonmagnetic, stainless-steel or other non-corrosive metal fasteners compatible with frames, stops, panels, reinforcements, plates, hardware, anchors, and other items being fastened.
B. Door Silencers: Manufacturer's standard continuous mohair, wool pile, or vinyl seals: Gray.
C. Smoke Seals: Intumescent strip or fire-rated gaskets: Gray.
D. Glazing Gaskets: Manufacturer's standard extruded or molded plastic, to accommodate glazing thickness indicated; black color.
E. Glazing: Comply with requirements in Division 08 Section "Glazing.”
F. Hardware: Comply with requirements in Division 08 door hardware Sections.

2.4 FABRICATION
A. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted or mitered connections.
B. Factory prepare interior aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
   1. Locate hardware as required by fire-rated label for assembly.
C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
   1. Locate removable stops on the inside of spaces accessed by keyed doors.
D. Fabricate components to allow secure installation without exposed fasteners.

2.5 GENERAL FINISH REQUIREMENTS
A. Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES
A. Clear Anodic Finish: AAMA 611, AA-M12C22A21, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine walls, floors, and ceilings, with Installer present, for conditions affecting performance of the Work.
B. Verify that wall thickness does not exceed standard tolerances allowed by throat size indicated.
C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. General: Install interior aluminum frames plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's printed installation instructions.

B. Set frames accurately in position and plumbed, aligned, and securely anchored to substrates.
   1. Install frames in accordance with the Manufacturer's printed installation instructions, reviewed submittals and reviewed mockup.
   2. At fire-protection-rated openings, install interior aluminum frames according to NFPA 80.

C. Install frame components in the longest possible lengths; components up to 96 inches long must be one piece.
   1. Use concealed installation clips to produce tightly fitted and aligned splices and connections.
   2. Secure clips to extruded main-frame components and not to snap-in or trim members.
   3. Do not leave screws or other fasteners exposed to view when installation is complete.

3.3 CLEANING

A. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended by frame manufacturer and according to AAMA 609 & 610.

B. Touch up marred frame surfaces so touchup is not visible from a distance of 48 inches. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION
SECTION 081416
FLUSH WOOD DOORS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Solid-core doors with wood-veneer.
   2. Factory finishing flush wood doors.
   3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.3 SUBMITTALS
A. Product Data:
   1. For each type of door indicated. Include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
   1. Indicate dimensions and locations of mortises and holes for hardware.
   2. Indicate dimensions and locations of cutouts.
   3. Indicate requirements for veneer matching.
   4. Indicate doors to be factory finished and finish requirements.
   5. Indicate molding of trim for cutouts.

C. Samples: For factory finished door faces.
   1. Factory finishes applied to actual door face veneer materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
   2. Frames for light openings, 6 inches long, for each material, type, and finish required.

D. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE
A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Source Limitations: Obtain flush wood doors and wood paneling from single manufacturer.

   1. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons and wrap bundles of doors in plastic sheathing.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.6 PROJECT CONDITIONS
A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

FLUSH WOOD DOORS
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1. Failures include, but are not limited to, the following:
   a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
   b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.


PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Algoma Hardwoods, Inc.
      2. Eggers Industries.
      5. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL
   A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
   B. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.
   C. Particleboard-Core Doors:
      1. Particleboard: ANSI A208.1, Grade LD-1.
      2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
         a. 8-inch top-rail blocking, in doors indicated to have closers.
         b. 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
         c. 5-inch midrail blocking, in doors indicated to have exit devices.
      3. Provide doors with structural-composite-lumber (SCL) cores instead of particleboard cores for the following door types:
         a. Indicated to receive exit devices.
         b. Doors with more than 40 percent of core removed.
         c. Lock and Light cutout stiles less then 5 1/2 inches between cutouts.
         d. Shipping and receiving doors.

2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH
   A. Interior Solid-Core Doors:
      1. Grade: Custom (Grade A faces).
      2. Species: As scheduled.
      3. Cut: As scheduled.
      5. Assembly of Veneer Leaves on Door Faces: Center-balance match.
      6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
      7. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
      8. Transom Match: Continuous match.
      9. Exposed Vertical Edges: Same species as faces.
      10. Core: Particleboard and comply with section 2.2.
      11. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.
      12. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

2.4 LIGHT FRAMES
   A. Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch thick, cold-rolled steel sheet; with factory baked-enamel or powder-coated finish; and approved for use in doors indicated.

2.5 FABRICATION
   A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of doors where indicated.
3. Pre-drill hinge screw holes at factory for templated hinges.
4. Factory drill raceways for power cords to electrified hardware as scheduled in Door Hardware Sets.
5. Where armor plates are specified in Door Hardware Sets, ensure blocking and labeling is sufficient in door and approves the attachment of the listed armor plate.

C. Openings: Cut and trim openings through doors in factory.
1. Light Openings: Trim openings with moldings of material glazing frame to be wood to match face veneer of door and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section “Glazing.”

2.6 FACTORY FINISHING
A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Finish doors at factory.
C. Transparent Finish:
   1. Grade: Premium.
   2. Finish: Meets or exceeds TR6 finish performance requirements as per WDMA I.S. 1A
   3. Staining: As scheduled.
   4. Effect: Semi-filled finish, produced by applying an additional finish coat to partially fill the wood pores.
   5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine doors and installed door frames before hanging doors.
   1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Hardware: For installation, see Division 08 Section “Door Hardware.”
B. Installation Instructions: Install doors to comply with manufacturer’s written instructions and the referenced quality standard, and as indicated.
C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING
A. Operation: Rehang or replace doors that do not swing or operate freely.
B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following:
   1. Access doors and frames for walls and ceilings.

1.3 SUBMITTALS
A. Product Data: For each type of access door and frame indicated. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
B. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other work.

1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain each type of access door(s) and frame(s) through one source from a single manufacturer.
B. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. NFPA 252 or UL 10B for vertical access doors and frames.
   2. ASTM E 119 for horizontal access doors and frames.
C. Size Variations: Obtain Architect’s acceptance of manufacturer’s standard-size units, which may vary slightly from sizes indicated.

1.5 COORDINATION
A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work, and indicate in the schedule specified in “Submittals” Article.

PART 2 - PRODUCTS

2.1 STEEL MATERIALS
A. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS) with A60 zinc-iron-alloy (galvannealed) coating or G60 mill-phosphatized zinc coating; stretcher-leveled standard of flatness; with minimum thickness indicated representing specified thickness according to ASTM A 924.
B. Steel Finishes: Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.
   1. Surface Preparation for Metallic-Coated Steel Sheet: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
   2. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
C. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.
D. Plaster Beads: Casing bead formed from 0.0299-inch zinc-coated steel sheet with flange formed out of expanded metal lath and in size to suit thickness of plaster.
2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Acudor Products, Inc.
2. Babcock-Davis; A Cierra Products Co.
4. J. L. Industries, Inc.
7. Milcor Inc.
8. Nystrom, Inc.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acudor Products, Inc.
2. Babcock-Davis; A Cierra Products Co.
4. J. L. Industries, Inc.
7. Milcor Inc.
8. Nystrom, Inc.

1. Locations: Wall and ceiling surfaces.
2. Door: Minimum 0.060-inch-thick sheet metal, set flush with exposed face flange of frame.
3. Frame: Minimum 0.060-inch-thick sheet metal with 1-inch-wide, surface-mounted trim.
4. Hinges: Continuous piano.
5. Latch: Cam latch operated by screwdriver with interior release.

1. Locations: Wall and ceiling surfaces.
2. Door: Minimum 0.060-inch-thick sheet metal, set flush with surrounding finish surfaces.
3. Frame: Minimum 0.060-inch-thick sheet metal with drywall bead flange.
4. Hinges: Continuous piano.
5. Latch: Cam latch operated by screwdriver with interior release.

1. Locations: Ceiling surfaces.
2. Door: Minimum 0.060-inch-thick sheet metal in the form of a pan recessed 5/8 inch for gypsum board infill.
3. Frame: Minimum 0.060-inch-thick sheet metal with drywall bead for gypsum board surfaces.
5. Latch: Cam latch operated by screwdriver with interior release.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
1. Exposed Flanges: Nominal 1 to 1-1/2 inches wide around perimeter of frame.
2. For trimless frames with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
3. For trimless frames with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to perimeter of frames.
4. Provide mounting holes in frames for attachment of units to metal or wood framing.
D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
1. For recessed doors with plaster infill, provide self-furring expanded metal lath attached to door panel.
E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.
B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.
3.2 ADJUSTING AND CLEANING
   A. Adjust doors and hardware after installation for proper operation.
   B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION
SECTION 084113

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

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 and interior storefront framing.
   2. Storefront framing for window walls.
   3. Exterior and interior manual-swing entrance doors and door-frame units.

1.3 DEFINITIONS
A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PERFORMANCE REQUIREMENTS
A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
   1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
   2. Dimensional tolerances of building frame and other adjacent construction.
   3. Failure includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
      d. Noise or vibration created by wind and by thermal and structural movements.
      e. Loosening or weakening of fasteners, attachments, and other components.
      f. Sealant failure.
      g. Failure of operating units.

B. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Loads:
   1. Design Wind Loads: As indicated on structural drawings or as otherwise determined using design wind loads applicable to Project from basic wind speed indicated in miles per hour, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure."
      a. Design Wind Speed: Refer to Structural Drawings.

D. Deflection of Framing Members:
   1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
   2. Deflection parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch, whichever is smaller.

E. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.

F. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft.
G. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. 

H. Water Penetration under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

1. Maximum Water Leakage: No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.

I. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
2. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
   a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
   b. Low Exterior Ambient-Air Temperature: 0 deg F.
3. Interior Ambient-Air Temperature: 75 deg F.

J. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 53 when tested according to AAMA 1503.

K. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.57 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.

B. Sustainable Submittal:
   1. Product data for adhesives and sealants used inside of the weatherproofing system, including printed statement of VOC content.
   2. Provide product cost and pre-and post-consumer recycled content.

C. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
   2. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Other Action Submittals:
   1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

F. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of aluminum-framed systems.
   2. Include design calculations.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions,
arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect’s approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

D. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.
E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Field testing shall be performed on mockups according to requirements in "Field Quality Control" Article.

1.7 PROJECT CONDITIONS
A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY
A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration caused by thermal movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Water leakage through fixed glazing and framing areas.
      e. Failure of operating components.
   2. Warranty Period: Two years from date of Substantial Completion.
B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by U.S. Aluminum; a brand of C.R. Laurence or comparable products by one of the following:
   1. EFCO Corporation.
   2. Kawneer North America; an Alcoa company.
   3. Oldcastle BuildingEnvelope.
   4. YKK AP America Inc.

2.2 MATERIALS
A. General: Provide aluminum materials with at least 30 percent recycled content.
B. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.

2.3 FRAMING SYSTEMS
A. Framing Members: Manufacturer’s standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   2. Glazing System: Retained mechanically with gaskets on four sides.
   3. Glazing Plane: As indicated.
B. Brackets and Reinforcements: Manufacturer’s standard high-strength aluminum with non-staining.
nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123 or ASTM A 153.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding flashing compatible with adjacent materials.

F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.
1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 GLAZING SYSTEMS
A. Glazing: As specified in Division 08 Section "Glazing."
B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

2.5 ENTRANCE DOOR SYSTEMS
A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
2. Door Design: Medium stile; 3-1/2-inch nominal width; Wide stile; 5-1/2-inch nominal width where required for security hardware.
B. Entrance Door Hardware: As specified in Division 08 Section "Door Hardware."

2.6 ACCESSORY MATERIALS
A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."
1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

2.7 FABRICATION
A. Form or extrude aluminum shapes before finishing.
B. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
C. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
D. Storefront Framing: Fabricate components for assembly using screw-spline system.
E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
1. At exterior doors, provide compression weather stripping at fixed stops.
2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three
silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
   1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
   2. At exterior doors, provide weather sweeps applied to door bottoms.

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES
A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
   1. Color: Dark bronze.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. General:
   1. Comply with manufacturer’s written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure non-movement joints.
   5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
   6. Seal joints watertight unless otherwise indicated.
B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.
E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.
F. Install glazing as specified in Division 08 Section "Glazing."
G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
   1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
   2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers’ written instructions using concealed fasteners to greatest extent possible.
H. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

3.3 ERECTION TOLERANCES
A. Install aluminum-framed systems to comply with the following maximum erection tolerances:
   1. Location and Plane:
      a. Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
      b. Alignment:
         a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
         b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.

B. Diagonal Measurements:
   Limit difference between diagonal measurements to 1/8 inch.

3.4 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections.
B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed systems with specified requirements shall take place as follows and in successive phases as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.

1. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing under "Performance Requirements" Article, but not more than 0.09 cfm/sq. ft., of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.

2. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure difference of 0.67 times the static-air-pressure difference specified for laboratory testing under "Performance Requirements" Article, but not less than 4.18 lbf/sq. ft., and shall not evidence water penetration.

3. Water Spray Test: Before installation of interior finishes has begun, a minimum area of 75 feet by 1 story of aluminum-framed systems designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

C. Repair or remove work if test results and inspections indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

E. Aluminum-framed assemblies will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.

END OF SECTION
SECTION 084126
ALL-GLASS ENTRANCES AND STOREFRONTS

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 manual-swinging all-glass entrance doors.

1.3 DEFINITIONS
A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PERFORMANCE REQUIREMENTS
A. General Performance: All-glass systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction.
B. Structural Performance: All-glass systems shall withstand the effects of gravity loads and the loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
C. Delegated Design: Design all-glass systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
D. Thermal Movements: Allow for thermal movements resulting from the following ambient and surface temperature changes.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.5 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for all-glass system.
B. Shop Drawings: Show fabrication and installation details, including the following:
   1. Plans, elevations, and sections.
   2. Details of fittings and glazing, including isometric drawings of rail fittings.
   3. Door hardware locations, mounting heights, and installation requirements.
C. Samples for Initial Selection: For each type of exposed finish indicated.
D. Other Action Submittals:
   1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, sidelights, transoms, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
   E. Delegated Design Submittal: For all-glass systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of all-glass systems.
   F. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
B. Engineering Responsibility: Prepare data for all-glass systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.
C. Source Limitations: Obtain all-glass systems from single source from single manufacturer.
D. Accessible All-Glass Entrance Doors: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
1.7 PROJECT CONDITIONS
   A. Field Measurements: Verify actual locations of walls and other construction contiguous with all-glass systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of all-glass systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Structural failures including excessive deflection, air infiltration, or water leakage.
         b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
         c. Failure of operating components.
      2. Warranty Period: Two years from date of Substantial Completion, except as follows:
         a. Concealed Floor Closers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      2. CR Lawrence

2.2 MATERIALS
   A. Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), tested for surface and edge compression per ASTM C 1048 and for impact strength per 16 CFR 1201 for Category II materials.
      1. Class 1: Clear monolithic.
         a. Thickness: 1/2 inch.
         b. Locations: As indicated on door schedule.
      2. Exposed Edges: Machine ground and flat polished.
   B. Aluminum Extrusions: ASTM B 221, with strength and durability characteristics of not less than Alloy 6063-T5.
   C. Stainless-Steel Cladding: ASTM A 666, Type 304.

2.3 METAL COMPONENTS
   A. Fitting Configuration:
      1. Manual-Swinging, All-Glass Entrance Doors: Continuous rail fitting at top and bottom.
   B. Rail Fittings:
      2. Height:
         a. Top Rail: As indicated.
         b. Bottom Rail: As indicated.
      3. Profile: Tapered flat.
      4. End Caps: Manufacturer's standard precision-fit end caps for rail fittings.
   C. Anchors and Fastenings: Concealed.
   D. Weather Stripping: Pile type, replaceable without removing all-glass entrance doors from pivots.

2.4 ENTRANCE DOOR HARDWARE
   A. General: Heavy-duty entrance door hardware units in sizes, quantities, and types recommended by manufacturer for all-glass entrance systems indicated. For exposed parts, match metal and finish of rail fittings.
   B. Concealed Floor Closers and Top Pivots: Center hung; BHMA A156.4, Grade 1; including cases, bottom arms, top walking beam pivots, plates, and accessories required for complete installation.
      1. Swing: Single or double acting as indicated.
         a. Positive Dead Stop: Coordinated with hold-open angle if any, or at angle selected.
      3. Opening-Force Requirements:
         a. Egress Doors: Not more than 15 lb/f to release the latch and not more than 30 lb/f to set the door in motion and not more than 15 lb/f to open the door to its minimum required width.
         b. Accessible Interior Swinging Sliding Doors: Not more than 5 lb/f to fully open door.
   C. Push-Pull Set: As selected.
D. Threshold: As indicated on hardware schedule, but Not more than 1/2 inch high.

2.5 FABRICATION
   A. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.
      1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.
   B. Factory assemble components and factory install hardware and fittings to greatest extent possible.

2.6 STAINLESS-STEEL FINISHES
   A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      1. Run grain of directional finishes with long dimension of each piece.
      2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      3. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Install all-glass systems and associated components according to manufacturer’s written instructions.
   B. Set units level, plumb, and true to line, with uniform joints.
   C. Maintain uniform clearances between adjacent components.
   D. Lubricate hardware and other moving parts according to manufacturer's written instructions.
   E. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.
   F. Install joint sealants as specified in Division 07 Section “Joint Sealants” and to produce weathertight installation.

3.3 ADJUSTING AND CLEANING
   A. Adjust all-glass entrance doors and hardware to produce smooth operation and tight fit at contact points and weather stripping.
      1. For all-glass entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch measured to the leading door edge.
   B. Remove excess sealant and glazing compounds and dirt from surfaces.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Exterior and interior, sliding, power-operated automatic entrances.

B. Related Sections:
1. Division 26 for electrical connections including conduit and wiring for automatic entrance operators and access-control devices.
2. Division 27 and 28 for coordination with building security and fire alarm systems.

1.3 DEFINITIONS
A. AAADM: American Association of Automatic Door Manufacturers.
B. Activation Device: Device that, when actuated, sends an electrical signal to the door operator to open the door.
D. Safety Device: Device that, to avoid injury, prevents a door from opening or closing.
E. For automatic door terminology, refer to for definitions of terms.

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design automatic entrances, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Design Wind Loads: As indicated on structural drawings or as otherwise determined using design wind loads applicable to Project from basic wind speed indicated in miles per hour, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure."
C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
D. Operating Temperature Range: Provide automatic entrances that operate within 0 degrees F and 120 degrees F.
E. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 1.25 cfm/sq. ft. of fixed entrance system area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft.
F. Opening-Force Requirements:
1. Power-Operated Doors: Not more than 50 lb/f required to manually set door in motion if power fails, and not more than 15 lb/f required to open door to minimum required width.
2. Breakaway Device for Power-Operated Doors: Not more than 50 lb/f required for a breakaway door or panel to open.
G. Entrapment Force Requirements:
1. Power-Operated Sliding Doors: Not more than 30 lb/f required to prevent stopped door from closing.

1.5 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic entrances. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For automatic entrances. Include plans, elevations, sections, details, hardware mounting heights, and attachments to other work.
1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Activation and safety devices.
4. Include hardware schedule and indicate hardware types, functions, quantities, and locations.
C. Samples for Initial Selection: For units with factory-applied color and metal matching finishes.
D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for automatic entrances.
E. Maintenance Data: For automatic entrances, safety devices, and control systems to include in maintenance manuals.
F. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE
A. Manufacturer Qualifications: A manufacturer with company certificate issued by AAADM.
B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project.
C. Certified Inspector Qualifications: Certified by AAADM.
D. Source Limitations for Automatic Entrances: Obtain automatic entrances from single source from single manufacturer.
E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
F. Power-Operated Door Standard: BHMA A156.10.
H. Emergency-Exit Door Requirements: Comply with requirements of authorities having jurisdiction for automatic entrances serving as a required means of egress.

1.7 PROJECT CONDITIONS
A. Field Measurements: Verify actual dimensions of openings to receive automatic entrances by field measurements before fabrication.

1.8 COORDINATION
A. Coordinate sizes and locations of recesses in concrete floors for recessed sliding tracks that control automatic entrances. Concrete, reinforcement, and formwork requirements are specified in Division 03.
B. Templates: Obtain templates for doors, frames, and other work specified to be factory prepared for installing automatic entrances and distribute to parties involved. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic entrances to comply with indicated requirements.
C. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of Project.
D. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with connections to power supplies and access-control system.

1.9 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of automatic entrances that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Structural failures including, but not limited to, excessive deflection.
   b. Faulty operation of operators, controls, and hardware.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
2. Warranty Period: Two years from date of Substantial Completion.
B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Warranty Period: 20 years from date of Substantial Completion.

1.10 MAINTENANCE SERVICE
A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of automatic entrance Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper automatic entrance operation at rated speed and capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.
1. Engage a certified inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to Owner.
2. Perform maintenance, including emergency callback service, during normal working hours.
3. Include 24-hour-per-day, 7-day-per-week, emergency callback service.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   1. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
   2. Sheet and Plate: ASTM B 209.
B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   1. Structural Shapes, Plates, and Bars: ASTM A 36.
   2. Cold-Rolled Sheet and Strip: ASTM A 1008.
C. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.
D. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
E. Glazing: As specified in Division 08 Section "Glazing."
F. Sealants and Joint Fillers: As specified in Division 07 Section "Joint Sealants."
G. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, non-corrosive, non-staining grout; complying with ASTM C 1107; of consistency suitable for application.
H. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements, except containing no asbestos; formulated for 30-mil thickness per coat.
I. Fasteners and Accessories: Manufacturer’s standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

2.2 SLIDING AUTOMATIC ENTRANCES
A. General: Provide manufacturer's standard automatic entrances including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, activation and safety devices, and accessories required for a complete installation.
B. Sliding Automatic Entrance:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Biparting-Sliding Units:
         1) Besam Automated Entrance Systems, Inc.; an ASSA ABLOY Group company.
         2) DORMA Automatics; Div. of DORMA Group North America.
         3) Horton Automatics; Div. of Overhead Door Corporation.
         4) Stanley Access Technologies; Div. of The Stanley Works.
   2. Configuration: Biparting-sliding doors, with two sliding leaves, and sidelites on each side.
      a. Traffic Pattern: Two way.
      d. Mounting: Between jambs.
   3. Operator Features:
      a. Power opening and closing.
      b. Drive System: belt.
   4. Sliding Door Carrier Assemblies and Overhead Roller Tracks: Manufacturer's standard carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track, or ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly.
      a. Rollers: Minimum of two ball-bearing roller wheels and two anti-rise rollers for each active
   5. Sliding Door Threshold: Manufacturer's standard threshold members and bottom-guide track system, with stainless-steel, ball-bearing-center roller wheels.
      a. Configuration: No threshold across door opening and guide track system at sidelites.
   6. Combination Activation and Safety Device: Combination motion/presence sensor.
   7. Activation Device: To activate door operator.
   8. Sidelite Safety Device: Presence sensor, mounted above each sidelite on side of door opening through which doors travel, to detect obstructions and to prevent door from opening.
2.3 ENTRANCE COMPONENTS

A. Framing and Transom Members: Manufacturer's standard extruded aluminum, minimum 0.125 inch thick and reinforced as required to support imposed loads.
   1. Nominal Size: As indicated on Drawings.
   2. Extruded Glazing Stops and Applied Trim: Minimum 0.062-inch wall thickness.

B. Stile and Rail Doors: Manufacturer's standard 1-3/4-inch-thick, glazed doors with minimum 0.125-inch-thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie-rods that span full length of top and bottom rails.
   2. Stile Design: Thin stile, less than 1-3/4-inch nominal width
   3. Rail Design: 5-inch nominal height
   4. Muntin Bars: Horizontal tubular rail member for each door; match stile design and finish.

C. Sidelite(s): Manufacturer's standard 1-3/4-inch-deep sidelite(s) and transom with minimum 0.125-inch-thick, extruded-aluminum tubular stile and rail members matching door design and finish.
   1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
   2. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and manufacturer's standard preformed gaskets.
   3. Muntin Bars: Horizontal tubular rail members for each sidelite; match stile design.

D. Headers: Fabricated from minimum 0.125-inch-thick extruded aluminum and extending full width of automatic entrance units to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.
   1. Mounting: Surface mounted Capacity: Capable of supporting doors up to 175 lb per leaf over spans up to 14 feet.

E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

F. Signage: Affixed to both sides of each door as required by BHMA A156.10 and BHMA A156.19 for type of door and its operation.
   1. Application Process: Door manufacturer's standard process
   2. Provide sign materials with instructions for field application after glazing is installed.

2.4 DOOR OPERATORS AND ACTIVATION AND SAFETY DEVICES

A. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.
   1. Door Operator Performance: Provide door operators that will open and close doors and maintain them in fully closed position when subjected to Project's design wind loads.
   2. Electromechanical Operators: Concealed, self-contained, overhead unit powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; UL 325; and with manual operation with power off.

B. Combination Motion/Presence Sensors: Self-contained units; consisting of both motion and presence sensors in a single metal or plastic housing; adjustable to provide detection field sizes and functions required by BHMA A156.10.
   1. Motion Sensor: K-band-frequency, microwave-scanner units; with adjustable relay hold time of not less than 2 to 10 seconds.
   a. Provide capability for switching between bi-directional and uni-directional detection.
   2. Presence Sensor: Infrared-scanner units; with adjustable relay hold time of not less than 2 to 10 seconds. Sensors shall remain active at all times.

C. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.5 HARDWARE

A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.

B. Breakaway Device for Power-Operated Doors: Provide breakaway device that allows door to swing out in direction of egress to full 90 degrees from any operating position. Maximum force to open door shall be 50 lbf according to BHMA A156.10. Interrupt powered operation of door operator while in breakaway mode.

C. Hinges:
1. Center-Pivot Sets: BHMA A156.4, Grade 1, with exposed parts of cast-aluminum alloy.
2. Offset Pivots: BHMA A156.4, Grade 1, with exposed parts of cast-aluminum alloy.
3. Butt Hinges: BHMA A156.1, Grade 1, 5-knuckle, 4-1/2-by-4-inch ball-bearing butts.
   a. Provide non-removable pins at hinges exposed on outside of door.
   b. Provide nonferrous hinges for doors exposed to weather.
   c. Provide 3 hinges at each leaf for doors up to 36 inches wide and 80 inches tall; provide 4 hinges at each leaf for taller or wider doors.

D. Automatic Locking for Sliding Door: Electrically controlled device mounted in header that automatically locks door against sliding when in closed position. Provide fail safe operation if power fails.
   1. Include concealed, vertical-rod exit devices, UL 305, with latching into threshold and overhead carrier assembly and released by full-width panic bar and that prevent emergency breakaway doors from swinging and that permit emergency egress.
   2. Include locking devices for sidelites, to prevent manual break out.

E. Dustproof Strikes for Sliding Doors: Recessed, floor-type, BHMA A156.16, Grade 1, to receive deadbolt.

F. Weather Stripping: Manufacturer's standard replaceable components.
   1. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
   2. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
   3. Weather Sweeps: Manufacturer's standard nylon brush sweep mounted to underside of door bottom.

2.6 FABRICATION

A. General: Factory-fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.
   1. Form aluminum shapes before finishing.
   2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
   3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match framing.
      a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
      b. Reinforce members as required to receive fastener threads.
   4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

B. Framing: Provide automatic entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
   1. Fabricate tubular and channel frame assemblies with manufacturer’s standard welded or mechanical joints. Provide sub-frames and reinforcement as required for a complete system to support required loads.
   2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
   3. Form profiles that are sharp, straight, and free of defects or deformations.
   4. Provide components with concealed fasteners and anchor and connection devices.
   5. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
   6. Fabricate exterior components to drain water passing joints and condensation and moisture occurring or migrating within system to the exterior.
   7. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
   8. Allow for thermal expansion of exterior units.

C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

D. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.

E. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA’s "Glazing Manual."

F. Hardware: Factory install hardware to greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.
   1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors and breakaway sidelights.
   2. Provide compression-type weather stripping at fixed stops of exterior doors. At locations without fixed stops, provide sliding-type weather stripping retained in adjustable strip mortised into door edge.
3. Provide weather sweeps mounted to underside of door bottoms of exterior doors.
4. Provide finger guards at each pivoted entrance door that has clearance at hinge side greater than 1/4 inch and less than 3/4 inch with door in any position. Anchor guards to hinge-jamb frame.

G. Activation and Safety Devices:
1. General: Factory install devices in doors and headers as required by BHMA A156.10 for type of door and direction of travel.

2.7 GENERAL FINISH REQUIREMENTS
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES
A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
   1. Color: Dark bronze.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrances.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. General: Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints. Seal joints watertight.
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.
   1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
   2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
   3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
   4. Level recesses for recessed thresholds using non-shrink grout.
   5. Provide thresholds at exterior doors.
C. Door Operators: Connect door operators to electrical power distribution system as specified in Division 26 Sections.
D. Access-Control Devices: Connect access-control devices to access-control system as specified in Division 28 Sections.
E. Activation and Safety Devices: Install and adjust devices to provide detection field and functions indicated.
F. Glazing: Install glazing as specified in Division 08 Section "Glazing."
G. Sealants: Comply with requirements specified in Division 07 Section "Joint Sealants" to provide weathertight installation.
   1. Set bottom-guide track system, framing members and flashings in full sealant bed.
   2. Seal perimeter of framing members with sealant.
H. Signage: Apply signage on both sides of each door and breakaway sidelight as required by referenced door standards.
I. Wiring within Automatic Entrance Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Provide and use lacing bars and distribution spools.
3.3 ADJUSTING
   A. Adjust door operators, controls, and hardware for smooth and safe operation and for weathertight closure; comply with requirements in BHMA A156.10.
   B. Lubricate operating hardware and other moving parts as recommended by manufacturer.
   C. Readjust door operators and controls after repeated operation of completed installation equivalent to 3 days’ use by normal traffic (100 to 300 cycles). Lubricate hardware, operating equipment, and other moving parts.

3.4 CLEANING AND PROTECTION
   A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.
      1. Comply with requirements in Division 08 Section “Glazing” for cleaning and maintaining glass.

3.5 DEMONSTRATION
   A. Engage a certified inspector to train Owner’s maintenance personnel to adjust, operate, and maintain automatic entrances.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Spider fittings for structural decorative glass enclosure.

1.2 RELATED WORK
A. Section 088113 “Decorative Glass Glazing” for acid etched decorative glass for exterior applications.

1.3 REFERENCE STANDARDS
A. AAMA 501.4 - Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts; 2009.
B. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers; 2010.
C. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2003.

1.4 SUBMITTALS
A. Product Data:
1. Shop Drawings:
   a. Plans, sections, elevations, and details with point support fittings identified by manufacturer's part numbers, dimensions, materials, finishes, connections, method of anchorage to structure and glass thickness and type.
2. Manufacturer's Qualification Statement.
3. Test Reports: Submit results of full-size mock-up testing. Reports of tests previously performed on glass wall cladding supported by CRL series point load fittings are acceptable. Test reports include tests performed in accord with ASTM E330, AAMA501.4, and AAMA 501.6.
4. Manufacturer's Instructions: Manufacturer's printed installation and cleaning instructions.

1.5 QUALITY ASSURANCE
A. Field Measurements: Verify actual dimensions by field measurement before fabrication; show recorded measurements on shop drawings.
B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 5 years of documented experience.
C. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years of documented experience.
D. Provide point support fittings from a single source.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. C.R. Laurence Co, Inc., 2200 E. 55th St., Los Angeles, CA 90058-3488; Tel: (323) 588-1281 Ext. 7770; Email: archmetals@crlaurence.com.

2.2 POINT SUPPORT FITTINGS
A. General: Fittings are stainless steel 316 Alloy; in brushed (BS suffix), or polished (PS suffix) finish. Heavy Duty Spider Fittings can accommodate glass thickness from 1/2 inch to 1-1/16 inch. Regular Duty Spider Fittings can accommodate glass thickness from 3/8 inch to 1/2 inch. Mini Spider Fittings are reduced in size for interior dividers, displays, and hand railing applications. Glass must be tempered glass (do not use with annealed, float, or raw glass).
2.3 SPIDER FITTINGS FOR STRUCTURAL GLASS
   A. Regular Duty Spider Fittings
      1. Post Mount
         a. Double Arm Fitting used to attach two in-line glass panels to a structural center post.
            1) PMR2BS
            2) PMR2PS
      2. Attachment Options
         a. Rigid Head Combination Glass Attachment Fitting provides a secure attachment and
            minimize deflection of glass panel as recommended by manufacturer. Flush (countersunk
            hole in glass) or cap (standard hole in glass) mount.
            1) RRF10BS
            2) RRF10PS

2.4 GLASS ATTACHMENTS
   A. Rigid Cap fittings for 1/2 inch to 5/8 inch thick tempered glass: Rigid combination fastener for 3/8 inch to
      5/8 inch thick tempered glass.
      1. For use with countersunk or standard hole with tempered glass up to 1/2 inch thick (RSF10BS),
         (RSF10PS).
      2. For use with countersunk or standard hole with tempered glass from 1/2 inch - 1-1/8 inch thick
         (HSF14BS), (HSF14PS).

2.5 MATERIALS
   A. Austenitic Stainless Steel castings: ASTM A743; 316 Alloy, Grade CF 8 or CF 8M.
   B. Fasteners: Stainless Steel bolts: ASTM F593; 316 Alloy

2.6 SPIDER FITTING HARDWARE AND ACCESSORIES
   A. Tools: As recommended by fitting manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify dimensions, tolerances, and method of attachment with other work.

3.2 INSTALLATION
   A. Install in accordance with manufacturer's instructions, approved shop drawings, and engineering
      calculations.
   B. Point support fittings to be mounted to structural post, or rod structure.
   C. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other
      irregularities.
   D. Provide alignment attachments and shims to permanently fasten system to building structure.
   E. Align assembly plumb and level, free of twist. Maintain assembly dimensional tolerances, aligning with
      adjacent work.

3.3 TOLERANCES
   A. Maximum Variation From True Position: 1/8 inch maximum in 12 ft. - 0 inch runs, non-cumulative.
   B. Maximum Offset From True Alignment Between Adjacent Members Butting or In-Line: 1/32 inch.

END OF SECTION
SECTION 087100
FINISH HARDWARE

PART 1 - GENERAL

SUMMARY
Section Includes: Provide all items of finish hardware required to adequately trim, hang, and operate all doors, as
is hereinafter specified and listed in the Hardware Schedule.
1. Provide hardware for doors and frames of unusual profile or shape or other special conditions.
2. Provide all necessary standard and special fasteners, screws, bolts, expansion shields or anchors to
   properly secure hardware to its intended door, frame, or other surface.

REFERENCES
The following reference standards and model code documents shall be used in estimating and detailing door
hardware, and shall considered as a standard of quality, function, and performance, as applicable:
6. NFPA-105 Smoke Control Door Assembly. (current year adopted)
8. A.D.A.A.G Americans with Disabilities Act Accessibility Guidelines.

ACTION SUBMITTALS
General: Submit the following in accordance with Section 01 33 00.
Product Data: Provide a catalog cut sheet, clearly marked and identified, illustrating and describing each product
included in the Hardware Schedule.
10. Include construction and installation details, material descriptions, dimensions of individual
    components and profiles, and finishes.
11. Formulate catalog cut sheets into sets and include a set with each copy of the Hardware Schedule
    submitted.
Door Hardware Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing
    fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door
    Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function,
    and finish of door hardware.
    a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and
       Format for the Hardware Schedule."
    b. Organization: Organize the Door Hardware Schedule into door hardware sets indicating
       complete designations of every item required for each door or opening.
    c. Content: Include the following information:
    d. Type, style, function, size, label, hand, and finish of each door hardware item.
    e. Complete designations of every item required for each door or opening including name and
       manufacturer.
    f. Fastenings and other pertinent information.
    g. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in
       door and frame schedule. Use same scheduling sequence and format and use same door
       numbers and hardware set numbers as in the Contract Documents.
    h. Explanation of abbreviations, symbols, and codes contained in schedule.
    i. Mounting locations for door hardware.
    j. Door and frame sizes and materials.
    k. Description of each electrified door hardware function, including location, sequence of
       operation, and interface with other building control systems.
12. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly
    where approval of the Door Hardware Schedule must precede fabrication of other Work that is critical
    in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work
    affected by door hardware, and other information essential to the coordinated review of the Door
    Hardware Schedule.
Samples for Verification: If so requested by the Architect, provide a sample of any product or item requested,
property marked and tagged, for the opening for which it is intended.
Keying: Provide a keying schedule, listing the levels of keying, (GGMK, GKD, MKD or KA) as well as an explanation
of the key system’s function, the key symbols used and the numbers of the doors controlled. Provide in
conjunction with the Door Index/Keying Schedule (which lists the door number, schedule heading, lock type and individual key symbol and remarks or special instructions) mentioned in above. Project shall be Masterkeyed and/or Grand Masterkeyed and provide two (2) keys per lockset or cylinder.

INFORMATIONAL SUBMITTALS
Operation and Maintenance Data: For each type of door hardware to include in maintenance manuals. Provide latest, revised and updated schedule of finish hardware, complete with catalog cuts and keying schedule. In addition, furnish one (1) copy of maintenance and parts manuals for those items for which they are readily available and normally provided.
13. Submit in accordance with provisions of Section 01 78 23.

QUALITY ASSURANCE
Substitutions: Request for substitutions for alternative hardware items will not be accepted on this Project unless specifically indicated. Specification indicates one (1) specified product, listed hereinafter in the Hardware Schedule, and two (2) acceptable alternative manufacturers for that product. If any specified product is listed as a “No Substitution” product, only that specified product shall be provided as indicated.
Installer Qualifications: An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
Supplier Qualifications: Door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
14. The hardware supplier shall be engaged regularly in the furnishing, delivery and servicing of contract builder's hardware and must be experienced and knowledgeable in all phases of estimating, detailing, scheduling, masterkeying, shipping and installation practices.
15. When electro-mechanical or electronic hardware is supplied, a qualified individual with a minimum five- (5) year's experience shall be available for assistance.
Architectural Hardware Consultant Qualifications: A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
Regulatory Requirements: Comply with provisions of the following:
Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
17. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
18. Preliminary key system schematic diagram.
19. Requirements for key control system.
20. Address for delivery of keys.
21. Location of Key Cabinet.

DELIVERY, STORAGE, AND HANDLING
Marking and Packaging: All items of hardware shall be delivered to the site in manufacturer's original cartons or boxes. Each item of hardware shall be marked with the abbreviation set forth on the Shop Drawings to ensure that the product reaches its installation destination without needing specific hardware product number knowledge.
Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
COORDINATION
Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

MAINTENANCE
Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
Maintenance Service: If there are any products listed hereinafter that normally require a maintenance or service contract, provide the Owner and Architect with details and costs of standard maintenance or service contract.

PART 2 - PRODUCTS
MANUFACTURERS
Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:
1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Hardware Schedule" Article.
Product manufacturers listed with an asterisk (*) denote the specified manufacturers listed in the Hardware Schedule. The remaining listed manufacturers will be acceptable substitutions. If only one manufacturer is listed this shall be considered a "No Substitution" specification as set forth in "Quality Assurance" Article, for that particular item.

MATERIALS
Screws and Fasteners: Provide all screws and fasteners of the proper size and type to properly anchor or attach the item of hardware scheduled. Provide all fasteners with Phillips heads, unless security type screws (spanner-head or torx-head) are hereinafter specified.
Hinges: Provide as follows:
2. On doors to exterior openings and main corridor doors, and other doors of high frequency use, provide a continuous, gear type hinge of appropriate weight.
3. Where regular ball bearing hinges are listed for other doors, provide one hinge for each 30-inch of door height.
4. The width of the hinges shall be sufficient to clear all trim that is mounted to the doorframe.
5. Acceptable Manufacturers:
   a. Ives*
   b. Stanley.
   c. Hager.
Continuous Hinges: Continuous hinges shall consist of three (3)-interlocking extrusions in a pinless assembly applied to the full height of the door. All continuous geared hinges shall be manufactured to template screw locations and be non-handed. All mortise hinges and half mortise hinges shall cover and wrap the door edge completely. Doorframe heads shall be extended for clearance on full or half mortise hinges versus downsizing doors for ease of repair and replacement. All frames shall be properly reinforced per manufacturer's standards.
7. Acceptable Manufacturers:
   a. Ives*
   b. Select.
   c. Pemko.
Locks: All locks shall incorporate a six pin tumbler system and be keyed to a existing GRANDMASTER SYSTEM as not to breach security of system in place. Keying system must be guaranteed of no duplication of existing change keys, master keys or grandmaster keys located in this Project. All keying shall be coordinated with Owner. Locks shall be Grade 1 mortise and/or cylindrical as hereinafter listed in the Hardware Schedule.
8. Acceptable Manufacturers:
   a. Schlage* (Basis of Design)
Lock Trim: Cylindrical/mortise locks are to be furnished with lever handle trim, as is hereinafter listed in the Hardware Schedule.
Flush Bolts: Manual flush bolts to have 12-inch rods for doors 7'-6". Doors over 7'-6" high shall have bolts with top rods of 18 inch or 24 inch to allow ease of access to bolt lever. Furnish dust proof strikes for all bottom bolts.
9. Acceptable Manufacturers:
   a. Ives*
   b. Trimco.
   c. Rockwood.

Exit Devices: Exit Devices shall be rim, mortise or vertical rod type as called for in the Hardware Schedule. Devices shall be of the touch-pad type as is hereinafter specified in the Hardware Schedule. Exit devices shall be constructed to allow cylinder to be removed and rekeyed without removing the device from the door either by removable core cylinders or construction of exit device. Exit devices shall be constructed to allow the conversion from one function to another simply within lock stile case and selecting proper outside trim as specified hereinafter in the Hardware Schedule. Devices shall be furnished with outside trim lever handles matching locks.

10. Acceptable Manufacturers:
    a. Von Duprin* (Basis of Design)

Door Closers: Door closers shall be of cast iron and rectangular design, furnished with a full cover. Provide complete with backcheck, delayed action and hold-open as indicated. Closers shall be mounted out of the line of sight wherever possible (i.e., room side of corridor doors, etc.) with parallel arm mounting on out-swinging doors. Mount closers to jamb or on brackets and/or drop plates, where special conditions require.

11. Acceptable Manufacturers:
    a. LCN* (Basis of Design)

Push Plates: Push plates are to be .050 brass, bronze or stainless steel with four (4) beveled edges, drilled and countersunk for screws, as is hereinafter specified in the Hardware Schedule.

12. Acceptable Manufacturers:
    a. Ives*
    b. Trimco.
    c. Hager.

Door Pulls: Door pulls shall be ADA compliant with a 2 1/2 inch projection from back of pull to face of door. All door pulls shall be thru-bolted or back-to-back mounted.

13. Acceptable Manufacturers:
    a. Ives*
    b. Rockwood*.
    c. Frascio.

Protective Plates: Protective plates shall be mop (6"), kick (10") or armor (34") and shall be minimum .050 thick brass, bronze, or stainless steel, with three (3) beveled edges, drilled and countersunk for screws. Plates shall be mounted to avoid louvers and/or glass kits.

14. Acceptable Manufacturers:
    a. Ives*
    b. Trimco.
    c. Hager.

Door Stops and Holders: Where a door strikes a wall at approximately 90 degrees, a suitable door stop shall be provided, either a wall bumper or floor stop. Where doors are undercut, provide floor stops with adequate height to properly stop the door. If door would not otherwise strike a wall, an overhead stop shall be provided. In-wall blocking for wall bumpers at stud walls shall be provided in accordance with Section 06 10 53. Provide reinforcing in frame and door for overhead stops.

15. Acceptable Manufacturers:
    a. Ives*
    b. Hager.
    c. Glynn-Johnson.

Thresholds and Weatherstrip: Weatherstripping to have aluminum housing, specified insert, and elongated mounting holes. Door sweeps shall be surface mounted, of aluminum/stainless steel housing with specified insert. Overhead drip caps to be of aluminum, have a 2 1/2-inch projection and be 4 inches wider than the door opening. Thresholds shall be of saddle type with no more than 1/2 inch rise. Weatherstripping and smoke seals shall be surface-mounted on doorstop and have 1/4" adjustment slots.

16. Acceptable Manufacturers:
    a. Zero*
    b. Hager.
    c. NGP.

Smoke Gasket: Smoke gasket shall comply with door and frame manufacturers for positive pressure tests for fire and smoke. (UBC 7-2, Parts 1 & 2/UL10C).

17. Acceptable Manufacturers:
    a. Zero*
    b. Reese.
    c. Pemko.
FINISHES

Hardware finishes shall match and be maintained to BHMA symbols, as indicated in the Hardware Schedule. Strict adherence to base metals and finish is required.

Provide Anti-Microbial finish for all lever sets, electronic lever sets, exit device trim and door push/pulls.

Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

KEYING

Keying System: Unless otherwise indicated, furnish for a keying system complying with the following requirements:

18. Master key or grand master key locks to Owner's existing system.

19. Cylinders are factory keyed operated by a change key, master key, and a grand master key. Conduct keying meeting with End User to define and document keying system instructions and requirements.

Keying of locks and cylinders throughout project shall be scheduled through a key meeting with Architect, Owner, and hardware supplier. Key schedule shall be prepared and submitted to the Owner for approval. Copies of final key schedule with the bitting instructions shall be submitted as part of the Project Record Documents.

KEY CONTROL

Provide key cabinet(s) manufactured by of sufficient capacity to handle all keys, plus 50 percent expansion. Provide key control cross-reference chart and accountability (sign-out) tags.

Acceptable Manufacturers:

a. Telkee*
b. Lund.

PART 3 - EXECUTION

EXAMINATION

Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

Proceed with installation only after unsatisfactory conditions have been corrected.

PREPARATION

Steel Doors and Frames: Comply with DHI A115 series.

1. Surface-Applied Door Hardware: Drill and tap doors and frames according to SDI 107 or ANSI A250.6, whichever is more stringent.

Wood Doors: Comply with DHI A115-W series.

INSTALLATION

Installation shall be by a qualified installer with a minimum five (5) year's experience in the installation of commercial grade hardware. Manufacturer's instructions shall dictate templating and installation.

Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:


Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstalling of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

4. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

5. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

Key Control System: Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.

Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect prior to installation.
Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section “Joint Sealants.”

FIELD QUALITY CONTROL
Perform final inspection with hardware installer and hardware supplier present to ensure correct installation and operation, and check for any damaged or defective items. Observe and inspect that all hardware has been installed to its correct destination in proper working order.

Independent Architectural Hardware Consultant: Owner reserves the right to engage a qualified independent Architectural Hardware Consultant to perform a separate independent inspection and to prepare an inspection report.

ADJUSTING
Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended.

6. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
7. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
8. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

At completion of the installation and prior to Substantial Completion, make final adjustments to door closures and other items of hardware. Leave all hardware clean and fully operable. Should any item be found to be defective, it shall be repaired or replaced as directed.

Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer’s Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

CLEANING AND PROTECTION
Clean adjacent surfaces soiled by door hardware installation.
Clean operating items as necessary to restore proper function and finish.
Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

DEMONSTRATION
Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section “Demonstration and Training.”

HARDWARE SCHEDULE
Provide hardware for each door to comply with requirements of this section.

Hardware Group No. 001
EACH TO HAVE:

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HARDWARE BY DOOR MFR

Hardware Group No. 003
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HARDWARE BY DOOR MFR
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Hardware Group No. 710AC
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FINISH HARDWARE
087100 - 8
Hardware Group No. 715A

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### Hardware Group No. C201

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-INGRESS BY THE CARD READER OR KEY OVERRIDE.
-FREE EGRESS BY LEVER
Hardware Group No. C205
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END OF SECTION
SECTION 088000
GLAZING

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 glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Doors.
   2. Storefront framing.
   3. Interior borrowed lites.

1.3 DEFINITIONS
A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
C. Interspace: Space between lites of an insulating-glass unit.

1.4 PERFORMANCE REQUIREMENTS
A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified professional engineer, using the following design criteria:
   1. Design Wind Pressures: As indicated on Drawings.
   2. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
      a. Basic Wind Speed: Refer to Structural Drawings.
   3. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
   4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
   5. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.5 PRECONSTRUCTION TESTING
A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
   1. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
   2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
   3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
   4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.
1.6 SUBMITTALS
A. Product Data: For each glass product and glazing material indicated.
B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
   1. Insulating glass.
C. Glazing Accessory Samples: For gaskets, sealants, and colored spacers, in 12-inch lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
F. Product Certificates: For glass and glazing products, from manufacturer.
G. Preconstruction adhesion and compatibility test report.

1.7 QUALITY ASSURANCE
A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
E. Source Limitations for Glass: Obtain insulating glass from single source from single manufacturer for each glass type.
F. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
G. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
H. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
I. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
J. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Install glazing in mockups specified in Division 08 Section "Aluminum-Framed Entrances and Storefronts and Glazed Aluminum Curtain Walls to match glazing systems required for Project, including glazing methods.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
K. Preinstallation Conference: Conduct conference at Project site.
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review temporary protection requirements for glazing during and after installation.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9 PROJECT CONDITIONS
A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F.
1.10 WARRANTY

A. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
1. Minimum Glass Thickness for Exterior Lites: 6.0 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
2. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
3. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
4. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.

B. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
2. For uncoated glass, comply with requirements for Condition A.
3. For coated vision glass, comply with requirements for Condition C (other coated glass).

C. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B, Type I, Quality-Q3, and complying with other requirements specified.
2. Tint Color: Match insulating glass.
3. Ceramic Coating Color: As selected by Architect from manufacturer's full range.

2.3 INSULATING GLASS

A. Basis of Design: Subject to compliance with requirements, provide products as specified GL-1; Vitro Architectural Glass; (formerly PPG); 400 Guys Run Road, Cheswick, PA 15024 (855. 887.6457), or GL-2; GL-3; Pilkington North America, 956 S Bartlett Rd Box #204 Bartlett, IL 60103 (630 830-1462), comparable products by one of the following submitted in accordance with Section 012500 “Substitution Procedures”:
1. Oldcastle.
2. Viracon.

B. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
2. Spacer: Manufacturer's standard spacer material and construction.
3. Desiccant: Molecular sieve or silica gel, or blend of both.
2.4 GLAZING GASKETS
A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain water-tight seal, made from one of the following:
1. Neoprene complying with ASTM C 864.
2. EPDM complying with ASTM C 864.
4. Thermoplastic polyolefin rubber complying with ASTM C 1115.

2.5 GLAZING SEALANTS
A. General:
1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 790.
      b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
      c. Pecora Corporation; 890.
      d. Tremco Incorporated; Spectrem 1.

2.6 GLAZING TAPES
A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   1. AAMA 804.3 tape, where indicated.
   2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.7 MISCELLANEOUS GLAZING MATERIALS
A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant backing in place for installation indicated.

2.8 FABRICATION OF GLAZING UNITS
A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
C. Grind smooth and polish exposed glass edges and corners.
2.9 MONOLITHIC-GLASS TYPES
A. Glass Type GL-2: Clear fully tempered float glass.
   2. Lite: Clear, fully tempered float glass.
   3. Thickness: 6.0 mm.
   4. Provide safety glazing labeling.

2.10 INSULATING-GLASS TYPES
A. Glass Type GL-1: Low-e-coated, clear insulating glass.
   2. Overall Unit Thickness: 1 inch.
   3. Thickness of Each Glass Lite: 6.0 mm.
   4. Outdoor Lite: Clear, Heat-strengthened float glass or fully tempered float glass.
   5. Interspace Content: Air.
   6. Indoor Lite: Clear, Heat-strengthened float glass or fully tempered float glass.
   7. Low-E Coating: Sputtered on second surface.
   8. Visible Light Transmittance: 51 percent minimum.
   9. Winter Nighttime U-Factor: 0.29 maximum.
   10. Solar Heat Gain Coefficient: 0.23 maximum.
   11. Provide safety glazing labeling.
B. Glass Type GL-2: Low-e-coated, tinted insulating glass.
   2. Overall Unit Thickness: 1 inch.
   3. Thickness of Each Glass Lite: 6.0 mm.
   4. Outdoor Lite: Tinted heat-strengthened float glass or fully tempered float glass.
   5. Interspace Content: Air.
   6. Indoor Lite: Clear, heat-strengthened float glass or fully tempered float glass.
   7. Low-E Coating: Sputtered on second surface.
   8. Visible Light Transmittance: 0.43 percent minimum.
   9. Winter Nighttime U-Factor: 0.33 maximum.
   10. Solar Heat Gain Coefficient: 0.34 maximum.
   11. Provide safety glazing labeling.
C. Glass Type GL-3: Low-e-coated, clear insulating glass by Pilkington (630 830-1462).
   1. Overall Unit Thickness: 1 inch.
   2. Thickness of Each Glass Lite: 6.0 mm.
   3. Outdoor Lite: Clear, Heat-strengthened float glass or fully tempered float glass.
   4. Interspace Content: Air.
   5. Indoor Lite: Clear, Heat-strengthened float glass or fully tempered float glass.
   8. Winter Nighttime U-Factor: 0.33 maximum.
   9. Solar Heat Gain Coefficient: 0.67 maximum.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep systems.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that
exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL
A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
G. Provide spacers for glass lites where length plus width is larger than 50 inches.
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING
A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
E. Do not remove release paper from tape until right before each glazing unit is installed.
F. Apply heel bead of elastomeric sealant.
G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)
A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass.
Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION
SECTION 088113
DECORATIVE GLASS GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Included Work in Other Sections:
   1. 084423 “Glazing Point Support Spider Fittings.”

1.2 SUMMARY
A. Section includes the following decorative glass for exterior applications:
   1. Acid etched.

1.3 DEFINITION
A. Glass Thickness: Indicated by thickness designations in millimeters according to ASTM C 1036.

1.4 PERFORMANCE REQUIREMENTS
A. General Performance: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.
B. Delegated Design: Design glass installed adjacent to walking surfaces, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   1. Differential deflection of adjacent unsupported edges shall not exceed glass thickness when subjected to 50 lbf/ft. applied horizontally to one panel at any point up to 42 inches above the adjacent walking surface.
   2. Base design on thickness at thinnest part of the glass.

1.5 SUBMITTALS
A. Product Data: For each decorative-glass and glazing product indicated.
B. Sustainable Submittals:
   1. Product data for glazing sealants, including printed statement of VOC content.
C. Shop Drawings: For decorative glass. Show fabrication and installation details. Include the following:
   1. Size and location of penetrations.
   2. Glazing method.
   4. Attachments to other work.
   5. Full-size details of edge-finished profiles.
D. Glass Samples: For the following products, 12 inches square:
   1. Each type of decorative glass.
E. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
F. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under NGA's Certified Glass Installer Program.
B. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
C. Source Limitations for Glass: Obtain each type of decorative glass from single source from single manufacturer.
D. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer, for each product and installation method.
E. Glazing Publications: Comply with published recommendations in GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual" unless more stringent requirements are indicated. See these
publications for glazing terms not otherwise defined in this Section or in referenced standards.

F. Safety Glass: Where safety glazing is indicated, comply with testing requirements in 16 CFR 1201 for Category II materials.
   1. Labeling: Permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard that glass complies with.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Protect decorative glass and glazing materials according to manufacturer's written instructions and as needed to prevent damage to surfaces and edges.
   B. Retain packaging and sequencing numbers for decorative-glass units.

1.8 PROJECT CONDITIONS
   A. Environmental Limitations: Do not deliver or install decorative glass until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   B. Field Measurements: Verify actual dimensions of openings and construction contiguous with decorative glass by field measurements before fabrication.

1.9 WARRANTY
   A. Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
      1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL
   A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
   B. Strength: Where float glass is indicated, provide annealed float glass, Kind FT heat-treated float glass as needed to comply with requirements indicated. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with requirements indicated. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

2.2 DECORATIVE GLASS TYPES
   A. Decorative Glass: Acid-etched glass with hydrofluoric and hydrochloric acids, evenly applied, according to manufacturer's standard process.
      1. Products: Subject to compliance with requirements, provide the following:
         a. As scheduled.
      2. Glass Type: Clear fully tempered float glass.
      3. Glass Thickness: 12.0 mm.
      4. Patterns: As scheduled.
      5. Silicone Back Coating: Recommended by glass fabricator for shop application.
      6. Color: As selected by Architect from manufacturer's full range.

2.3 GLAZING MATERIALS
   A. Glazing Gaskets, Sealants, Tapes, and Miscellaneous Glazing Materials: As specified in Division 08 Section "Glazing.
         a. Color: As selected by Architect from manufacturer's full range.
   B. Joint Sealants: As specified in Division 07 Section "Joint Sealants."
2.4 HARDWARE FOR GLASS INSTALLATION
   A. Hardware: Panel support bars: refer to section 084423 "Glazing Point Support Glazing Fittings."
   B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color
      and texture where fasteners are exposed.
   C. Gaskets and Wedges: Manufacturer’s standard, compatible with decorative glass type indicated.

2.5 Anchors and Inserts: Provide devices as required for hardware installation. Provide toothed or lead-shield
   expansion-bolt devices for drilled-in-place anchors. Provide [galvanized] [stainless-steel] anchors and
   inserts for applications on inside face of exterior walls and where indicated.

2.6 DECORATIVE-GLASS FABRICATION
   A. Fabricate decorative glass and provide other glazing products in sizes required to glaze openings
      indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with
      written recommendations of product manufacturer and with referenced glazing standard.
   B. Edge Finishing: Fabricate finished edges to produce smooth, polished edges without chips, scratches, or
      warps.
      1. Finished Edge: Flat polished.
      2. Edge-Finished Glass Adhesive: Clear, non-yellowing, as recommended by manufacturer.
   C. Lite Treatment: As indicated on Drawings with smooth, uniform edge.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine decorative-glass framing members, with Installer present, for compliance with the following:
      1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at
         corners.
      2. Minimum required face or edge clearances.
      3. Effective sealing between joints of decorative-glass framing members.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove
      coatings not firmly bonded to substrates.
   B. Examine glazing units to locate orientation of outer surfaces as indicated on Drawings. Label or mark
      units as needed so that surface orientation is readily identifiable. Do not use materials that leave visible
      marks in the completed Work.

3.3 INSTALLATION
   A. Set decorative-glass units in each series true in line with uniform orientation, pattern, draw, bow, and
      similar characteristics.
   B. Set glass lites with proper orientation so that each outer surface faces the direction indicated on Drawings.
   C. Set decorative glass in locations indicated on Drawings. Install glass with hardware and accessories
      according to hardware manufacturer’s written instructions. Attach hardware securely to mounting surfaces
      and building structure.
   D. Set decorative glass in locations indicated on Drawings and as specified in Division 088000 Section
      “Glazing.”

3.4 GLAZING, GENERAL
   A. Decorative Glass: Install glazing as specified in Division 08 Section “Glazing.”
   B. Comply with combined written instructions of manufacturers of gaskets, glass, sealants, tapes, and other
      glazing materials unless more stringent requirements are indicated, including those in referenced glazing
      publications.
   C. Adjust glazing channel dimensions during installation as required by Project conditions to provide
      necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with
      reasonable tolerances.
   D. Protect glass edges from damage during handling and installation. Remove damaged glass from Project
      site and legally dispose of off Project site. Damaged glass is glass with edge damage or other
      imperfections that, when installed, could weaken glass and impair performance and appearance.
   E. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction
      testing.
   F. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications,
unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

G. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

H. Provide spacers for glass lites where length plus width is more than 50 inches.
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances, and to comply with system performance requirements.
   2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

I. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.5 SEALANT GLAZING (WET)
   A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
   B. Force sealants into glazing channels and between glass-to-glass joints to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
   C. Tool exposed surfaces of sealants smooth.

3.6 CLEANING AND PROTECTION
   A. Protect decorative glass from damage immediately after installation by attaching crossed streamers to framing and held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
   B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
   C. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
   D. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION
SECTION 088300

MIRRORS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes the following types of silvered flat glass mirrors:
      1. Annealed monolithic glass mirrors.
      2. Film-backed Tempered glass mirrors qualifying as safety glazing.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated.
      1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
   B. Sustainable Submittals:
      1. Product data for adhesives, including printed statement of VOC content.
   C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.
   D. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.
   E. Maintenance Data: For mirrors to include in maintenance manuals.
   F. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE
   A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
   B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
   C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.
   D. Glazing Publications: Comply with the following published recommendations:
      1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
      2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
   E. Safety Glazing Products: For film-backed tempered mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.
   F. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing film and substrates on which mirrors are installed.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
   B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.6 PROJECT CONDITIONS
   A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.
1.7 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SILVERED FLAT GLASS MIRRORS
   A. Glass Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Arch Aluminum & Glass Co., Inc.
         b. Avalon Glass and Mirror Company.
         c. Binswanger Mirror; a division of Vitro America, Inc.
         d. Guardian Industries.
         e. Virginia Mirror Company, Inc.
   B. Clear Glass: Mirror Select Quality.
      1. Nominal Thickness: 6.0 mm.
   C. Tempered Clear Glass: Mirror Glazing Quality, for blemish requirements; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
      1. Nominal Thickness: 6.0 mm.

2.2 MISCELLANEOUS MATERIALS
   A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
   B. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. OSI Sealants, Inc.
         b. Palmer Products Corporation.
         c. Pecora Corporation.
   C. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.3 FABRICATION
   A. Mirror Sizes: To suit Project conditions, and before tempering, cut mirrors to final sizes and shapes.
   B. Cutouts: Fabricate cutouts before tempering for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.
   C. Mirror Edge Treatment: Flat polished.
      1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
      2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.
   D. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.
PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
   B. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
   C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION
   A. Comply with mastic manufacturer’s written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer’s special bond coating where applicable.

3.3 INSTALLATION
   A. General: Install mirrors to comply with mirror manufacturer’s written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
   B. Provide a minimum air space of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
   1. Wall-Mounted Mirrors: Install mirrors with mastic.
      2. Install mastic as follows:
         a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
         b. Apply mastic to comply with mastic manufacturer’s written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
         c. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch between back of mirrors and mounting surface.

3.4 CLEANING AND PROTECTION
   A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
   B. Do not permit edges of mirrors to be exposed to standing water.
   C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
   D. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION
SECTION 088700

GLAZING SURFACE FILMS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes film products applied to glass surfaces

1.2 PERFORMANCE REQUIREMENTS
A. Fire Performance: Surface burning characteristics when applied to 1/4 inch, nominal clear glass and tested in accordance with ASTM E84:
   1. Flame Spread Index: 25 maximum.
   2. Smoke Developed: 50 maximum.
B. Minimum Peel Strength: 2,000 grams per inch, average of two specimens when tested in accordance with ASTM D 3330.

1.3 ACTION SUBMITTALS
A. Product Data: For each film product indicated.
B. Samples for Color Selection: Manufacturer’s standard sample sets showing the full range of colors available for each type of product indicated.
C. Samples for Verification: 12-inch square samples of each type of glazing film specified, in color specified.
D. Shop Drawings: identify location for each type of film indicated.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 CLOSEOUT SUBMITTALS
A. Warranty: Special warranty specified in this Section.
B. Maintenance Data and Replacement Instructions: For each type of film overlay to include in maintenance manuals.

1.6 QUALITY ASSURANCE
A. Manufacturer Qualifications: Engage a firm experienced in manufacturing systems similar to those indicated for this Project and meeting the standards of the International Standards Organization (ISO), ISO 9001 Quality Assurance in Production and Installation.
B. Installer Qualifications: Engage an experienced installer certified, licensed, or otherwise qualified by film manufacturer as having the necessary experience, staff, and training to install manufacturer’s products according to specified requirements.
C. Source Limitations: Obtain each type of film overlay through one source from a single manufacturer to provide products of consistent quality in appearance and physical properties.
D. Mockups: Apply glazing films in locations as directed to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
   1. Obtain approval of field samples before continuing with remainder of installation.
   2. Maintain field samples during remainder of installation in an undisturbed condition as a standard for judging the completed Work.
   3. Approved field samples may become part of the completed Work.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Delivery: Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.
B. Store and protect glazing films according to manufacturer’s written instructions and as needed to prevent damage, condensation, temperature changes, direct exposure to sun, or other causes.

GLAZING SURFACE FILMS
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1.8 PROJECT CONDITIONS
   A. Environmental Limitations: Do not proceed with film installation when ambient and substrate temperature conditions are outside limits permitted by manufacturer and when glass substrates are wet from frost, condensation, or other causes.

1.9 WARRANTY
   A. Manufacturer's Warranty: Fully executed warranty, written in favor of the Owner, agreeing to replace films that deteriorate as defined in "Definitions" Article, within 5 years from date of original installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. CPFilms Inc.; LLumar Films.
      2. 3M
      3. Solyx, SimGlas
      4. Huper Optik

2.2 GLAZING SURFACE FILMS (DF)
   A. Film Overlay: Single-layered applied glazing film products, applied to interior glass surfaces, consisting of the following (from outboard surface to inboard surface), as applicable to each type of film indicated:
      1. Removable release liner.
      2. Pressure sensitive adhesive with integral ultraviolet absorbers.
      3. Clear, dyed, or printed pattern layer of polyester film.
      4. Possible layer of metallized or sputtered polyester film.
      5. Possible scratch resistant coating.
   B. Colors: As scheduled.
   C. Basis of Design: As scheduled.
   D. Opacities: As scheduled.

2.3 GLAZING FILM ACCESSORIES
   A. General: Provide products complying with requirements of glazing film manufacturer for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
   B. Adhesive: Pressure Sensitive acrylic adhesive system.
   C. Cleaners, Primers, and Sealers: Types recommended by glazing film manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine glass and surrounding adjacent surfaces for conditions affecting installation.
      1. Report conditions that may adversely effect installation. In report, include description of any glass that is broken, chipped, cracked, abraded, or damaged in any way.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Comply with manufacturer's written instructions for surface preparation.
   B. Immediately before beginning installation of films, clean glass surfaces of substances that could impair glazing film's bond, including mold, mildew, oil, grease, dirt and other foreign materials.
   C. Blade the inside surface of window glass with industrial razors to ensure removal of foreign contaminants.
   D. Protect window frames and surrounding surfaces and materials from damage during installation.
3.3 INSTALLATION
   A. General: Comply with glazing film manufacturers' written installation instructions applicable to products and applications indicated, except where more stringent requirements are indicated.
   B. Install film continuously, but not necessarily in one continuous length. Install with no gaps or overlaps.
   C. If seamed, install with no gaps or overlaps. Install seams vertical and plumb. No horizontal seams allowed.
   D. Do not remove release liner from film until just before each piece of film is cut and ready for installation.
   E. Install film with mounting solution and custom cut to the glass with neat, square corners and edges to within 1/8 inch of the window frame.
   F. Remove air bubbles, wrinkles, blisters, and other defects.
   G. After installation, view film from a distance of 10 feet against a bright uniform sky or background. Film shall appear uniform in appearance with no visible streaks, banding, thin spots or pinholes.
      1. If installed film does not meet this criteria, remove and replace with new film.

3.4 CLEANING
   A. Remove excess mounting solution at finished seams, perimeter edges, and adjacent surfaces.
   B. After application of film, wash film using cleaning methods recommended by glazing film manufacturer. Do not use abrasive-type cleaning agents or bristle brushes.
   C. Replace films that cannot be cleaned.

END OF SECTION
SECTION 092216
NON-STRUCTURAL METAL FRAMING

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. Non-load-bearing steel framing systems for interior gypsum board assemblies.
      2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS
   A. Evaluation Reports: For firestop tracks, from ICC-ES.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
   B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS
   A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
      1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
   B. Studs and Runners: ASTM C 645.
      1. Steel Studs and Runners:
         a. Minimum Base-Metal Thickness: 0.0179 inches unless indicated otherwise on Drawings or below.
         1) Interior Metal Stud/Gypsum Board Assemblies, Typical Locations: Withstand lateral loading (air pressure) of 5 psf with deflection limit not more than L/240 of partition height.
         2) Interior Metal Stud/Gypsum Board Assemblies at Atriums, Lobbies, Service Corridors, Exit Corridors, Elevator Lobbies, Vertical Shafts, and walls receiving plaster veneer: Withstand lateral loading (air pressure) of 7.5 psf with deflection limit not more than L/360 of partition height.
         3) Interior Metal Stud/Gypsum Board Assemblies at Locations with Ceramic Tile or Other Hard Surface Finishes: Withstand typical lateral loading (air pressure) with deflection limit not more than L/360 of partition height, minimum 0.0299 inch studs at 16 inches on center.
         4) Where wall mounted equipment, woodwork, and casework items are indicated or elsewhere as shown on Drawings, provide minimum 0.0598 inch studs
         5) At jambs of openings provide two minimum 0.0359 inch studs.
6) Ceilings: At ceilings using mold-mildew resistant gypsum framing to be 16 inches o.c. for 5/8 inches gypsum board.

7) Refer to Division 5 for stud framing which is exposed to wind loads and for studs carrying heavy vertical loads (cement plaster, manufactured stone masonry, stone tile thicker than 3/4 inch, etc)

b. Where partition heights exceed stud manufacturer’s recommended spans, provide one of the following:
1) Heavier stud gage.
2) Closer stud spacing.
3) Deeper stud size (space permitting); As approved by Architect.
4) Above ceiling bracing, anchored to structure above.

c. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Clark Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
      2) MBA Building Supplies;  
      3) Steel Network Inc. (The); VertiClip SLD Series.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Metal Thickness: 0.018 inch.

E. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
   1. Depth: As indicated on Drawings.
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base-Metal Thickness: 0.018 inch.
   2. Depth: 7/8 inch.

G. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.

H. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges.
   1. Depth: 3/4 inch.
   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
   3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

I. Curved Track:

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Hanger Attachments to Concrete:
   1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
      a. Type: Postinstalled, expansion anchor.
   2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch- wide flanges.
   1. Depth: 2-1/2 inches.

F. Furring Channels (Furring Members):
   1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
   2. Steel Studs and Runners: ASTM C 645.
      a. Minimum Base-Metal Thickness: 0.018 inch.
   a. Minimum Base-Metal Thickness: 0.018 inch.
4. Resilient Furring Channels: 1/2-inch deep members designed to reduce sound transmission.
G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Chicago Metallic Corporation; Drywall Grid System.
      c. USG Corporation; Drywall Suspension System.

2.4 AUXILIARY MATERIALS
A. General: Provide auxiliary materials that comply with referenced installation standards.
B. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
C. Isolation Strip at Exterior Walls: Provide the following:
   1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION
3.1 EXAMINATION
A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
   1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL
A. Installation Standard: ASTM C 754.
   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
C. Install bracing at terminations in assemblies.
D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES
A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
   1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
   2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
   3. Partitions with Security Mesh: 8 inches o.c., unless otherwise indicated or required to comply with span and deflection design criteria.
B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
C. Install studs so flanges within framing system point in same direction.
D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   a. Install two studs at each jamb unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

4. Curved Partitions:
   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:
   1. Screw to wood framing.
   2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Z-Furring Members:
   1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
   2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
   3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
   1. Hangers: 48 inches o.c.
   2. Carrying Channels (Main Runners): 48 inches o.c.
   3. Furring Channels (Furring Members): 16 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
   3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   5. Do not attach hangers to steel roof deck.
   6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.
C. Samples: For each type of finish coat indicated; 12 by 12 inches, and prepared on rigid backing.

1.4 QUALITY ASSURANCE
A. Fire-Resistance Ratings: Where indicated, provide portland cement plaster assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
B. Mockups: Before plastering, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Install mockups for each type of finish indicated.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
C. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.6 PROJECT CONDITIONS
A. Comply with ASTM C 926 requirements.
B. Exterior Plasterwork:
1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
2. Apply plaster when ambient temperature is greater than 40 deg F.
3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
C. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2 - PRODUCTS

2.1 METAL LATH
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Alabama Metal Industries Corporation; a Gibraltar Industries company.
   b. CEMCO.
   c. Clark Western Building Systems.
   d. Dietrich Metal Framing; a Worthington Industries company.
   e. MarinoWARE.
   f. Phillips Manufacturing Co.
2.2 ACCESSORIES
A. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Metal Accessories:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Alabama Metal Industries Corporation; a Gibraltar Industries company.
   b. CEMCO.
   c. Clark Western Building Systems.
   d. Dietrich Metal Framing; a Worthington Industries company.
   e. MarinoWARE.
   f. Phillips Manufacturing Co.
5. Cornerbeads: Fabricated from zinc.
   a. Small nose cornerbead with expanded flanges; use unless otherwise indicated.
   b. Small nose cornerbead with perforated flanges; use on curved corners.
   c. Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing masonry corners.
   d. Bull nose cornerbead, radius 3/4 inch minimum, with expanded flanges; use at locations indicated on Drawings.
6. Casing Beads: Fabricated from zinc; square-edged style; with expanded flanges.
7. Control Joints: Fabricated from zinc; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
8. Expansion Joints: Fabricated from zinc; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
9. Two-Piece Expansion Joints: Fabricated from zinc; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch wide; with perforated flanges.

2.3 MISCELLANEOUS MATERIALS
A. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch long, free of contaminants, manufactured for use in portland cement plaster.
C. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
D. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.
E. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter, unless otherwise indicated.

2.4 PLASTER MATERIALS
A. Portland Cement: ASTM C 150, Type I.
B. Sand Aggregate: ASTM C 897.
C. Perlite Aggregate: ASTM C 35.
D. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems, formulated with colorfast mineral pigments and fine aggregates; for use over portland cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dryvit Systems, Inc.; Dryvit TAFS.
   c. LaHabra, a brand of ParexLaHabra, Inc.; Acrylic Finish.
   d. Parex, Inc., a brand of ParexLaHabra, Inc.; e-lastic.
   e. Senergy, BASF Wall Systems, Inc.; Senerflex.
   f. Sto Corp.; Powerwall Finish.
2.5 PLASTER MIXES
A. General: Comply with ASTM C 926 for applications indicated.
   1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. 
      Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed  
      1 lb of fiber/ cu. yd. of cementitious materials.
B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
   1. Portland and Masonry Cement Mixes:
      a. Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry 
         cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
      b. Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry 
         cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than 
         volume of aggregate used in scratch coat.
C. Factory-Prepared Finish-Coat Mixes: For ready-mixed finish-coat plasters acrylic-based finish coatings, 
   comply with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in 
   anchors, and structural framing, for compliance with requirements and other conditions affecting 
   performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by 
   plastering.
B. Prepare solid substrates for plaster that are smooth or that do not have the suction capability required to 
   bond with plaster according to ASTM C 926.

3.3 INSTALLATION, GENERAL
A. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations 
   from listing organization and publication indicated on Drawings.

3.4 INSTALLING METAL LATH
A. Expanded-Metal Lath: Install according to ASTM C 1063.
   2. Horizontal Framing: Install flat diamond-mesh lath.

3.5 INSTALLING ACCESSORIES
A. Install according to ASTM C 1063 and at locations indicated on Drawings.
B. Reinforcement for External Corners:
   1. Install lath-type, external-corner reinforcement at exterior locations.
   2. Install cornerbead at interior and exterior locations.
C. Control Joints: Install control joints at locations indicated on Drawings or in specific locations approved by 
   Architect for visual effect as follows:
   1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
      a. Vertical Surfaces: 144 sq. ft..
      b. Horizontal and other Nonvertical Surfaces: 100 sq. ft..
   2. At distances between control joints of not greater than 18 feet o.c.
   3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater 
      than 2-1/2:1.
   4. Where control joints occur in surface of construction directly behind plaster.
   5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and 
      to relieve the stress that occurs at the corner formed by the dimension change.
3.6 PLASTER APPLICATION
   A. General: Comply with ASTM C 926.
      1. Do not deviate more than plus or minus 1/4 inch in 10 feet from a true plane in finished plaster surfaces, as measured by a 10-foot straightedge placed on surface.
      2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
      3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
   B. Walls; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 3/4-inch thickness.
   C. Ceilings; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 3/4 inch thick.
   D. Plaster Finish Coats: Apply to provide finish to match Architect's sample.
   E. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.
   F. Concealed Exterior Plasterwork: Where plaster application will be used as a base for adhered finishes, omit finish coat.

3.7 PLASTER REPAIRS
   A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.8 PROTECTION
   A. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION
SECTION 092900

GYPSUM BOARD

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 gypsum board.
2. Tile backing panels.

1.3 SUBMITTALS
A. Product Data: For each type of product.
B. Samples: For the following products:
1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.4 QUALITY ASSURANCE
A. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Install mockups for the following:
a. Each level of gypsum board finish indicated for use in exposed locations.
2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING
A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS
A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
D. Install cavity wall insulation and interior gypsum board only after building is enclosed with exterior wall assembly as detailed in the drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. VOC Limits: any adhesives, sealants, paints, or coatings shall meet the VOC limits indicated in Section 018113.
B. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
2.2 GYPSUM BOARD, GENERAL
A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Gypsum.
   2. CertainTeed Corp.
   3. Georgia-Pacific Gypsum LLC.
   4. Lafarge North America Inc.
   6. PABCO Gypsum.
   7. Temple-Inland.
   8. USG Corporation.
B. Gypsum Wallboard: ASTM C 1396/C 1396M.
   1. Thickness: 5/8".
   2. Long Edges: Tapered.
C. Gypsum Board, Type X: ASTM C 1396/C 1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered.
D. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
   1. Thickness: 1/4 inch.
   2. Long Edges: Tapered.
E. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered.

2.4 SPECIALTY GYPSUM BOARD
A. Gypsum Board, Type C: ASTM C 1396/C 1396M. Manufactured to have increased fire-resistive capability.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. American Gypsum; Firebloc Type C.
      b. CertainTeed Corp.; ProRoc Type C.
      c. Georgia-Pacific Gypsum LLC; Fireguard C.
      d. National Gypsum Company; Gold Bond Fire-Shield C.
      e. Temple-Inland; Type TG-C.
      f. USG Corporation; Firecode C Core.
   2. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
B. Glass-Mat Interior Gypsum Board: ASTM C 1658/C 1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Georgia-Pacific Gypsum LLC; DensArmour Plus.
      b. Temple-Inland; GreenGlass Interior Glass-Mat Board.
   2. Core: 5/8 inch, Type X .
   4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
C. Acoustically Enhanced Gypsum Board: ASTM C 1396/C 1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed; SilentFX.
      b. National Gypsum Company; Sound Break.
      c. Quiet Solution, Quiet Rock.
      d. Temple-Inland; ComfortGuard Sound Deadening Board.
   2. Core: 5/8 inch, Type X .
   1. Core: 5/8 inch, Type X.
   2. Long Edges: Tapered.
2.5 TILE BACKING PANELS
A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; GlasRoc Tile Backer.
      b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
      c. National Gypsum; e2XP Tile Backer.
      d. Temple-Inland; GreenGlass Fiberglass-Faced Tile Backer.
   2. Core: 5/8 inch, Type X.
   3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
B. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. C-Cure; C-Cure Board 990.
      b. CertainTeed Corp.; FiberCement.
      c. Custom Building Products; Wonderboard.
      d. James Hardie Building Products, Inc.; Hardiebacker.
      e. National Gypsum Company, Permabase Cement Board.
      f. USG Corporation; DUROCK Cement Board.
   2. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
   3. Thickness: 5/8".

2.6 TRIM ACCESSORIES
A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
   2. Shapes:
      a. Cornerbead.
      b. Bullnose bead.
      c. LC-Bead: J-shaped; exposed long flange receives joint compound.
      d. L-Bead: L-shaped; exposed long flange receives joint compound.
      e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
      f. Expansion (control) joint.
B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fry Reglet Corp.
      b. Gordon, Inc.
      c. Pittcon Industries.
   2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
   3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.7 JOINT TREATMENT MATERIALS
A. General: Comply with ASTM C 475/C 475M.
B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
   3. Tile Backing Panels: As recommended by panel manufacturer.
C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
      a. Use setting-type compound for installing paper-faced metal trim accessories.
   3. Fill Coat: For second coat, use drying-type, all-purpose compound.
   4. Finish Coat: For third coat, use drying-type, all-purpose compound.
   5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.
D. Joint Compound for Tile Backing Panels:
   1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
   2. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.8 AUXILIARY MATERIALS
A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
   1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pecora Corporation; AC-20 FTR or AIS-919.
      c. USG Corporation; SHEETROCK Acoustical Sealant.
   2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
   B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL
   A. Comply with ASTM C 840.
   B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
   C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
   D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
   E. Form control and expansion joints with space between edges of adjoining gypsum panels.
   F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
      1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
      2. Fit gypsum panels around ducts, pipes, and conduits.
      3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
   G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
   H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
   I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
   J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.
3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
   1. Type X: Vertical surfaces unless otherwise indicated.
   2. Flexible Type: Apply in double layer at curved assemblies.
   3. Ceiling Type: Ceiling surfaces.
   4. Type C: Where required for specific fire-resistance-rated assembly indicated.
   5. Glass-Mat Interior Type: Behind wall tile except where tile backer board is scheduled.
   6. Acoustically Enhanced Type: As indicated on Drawings.

B. Single-Layer Application:
   1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels vertically (parallel to framing unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
      a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
      b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
   3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
   4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:
   1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
   2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
   3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
   4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A108.11.

B. Where tile backing panels abut other types of panels in same plane, use same thickness panel to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Wall: Control joints shall be installed where a wall or partition runs in an uninterrupted straight plane exceeding 30 linear feet, or 900 sq ft.
   1. Ceiling with Perimeter relief: Control joints in interior ceilings with perimeter relief shall be installed so that linear dimensions between control joints do not exceed 50 ft or 2500 sq. ft
   2. Ceiling, without perimeter relief: Control joints in interior ceilings without perimeter relief shall be installed so that linear dimensions between control joints do not exceed 30 ft
   3. Exterior: Control joints in exterior ceilings and soffits shall be installed so that linear dimensions between control joints do not exceed 30 ft. at acoustical or fire-rated walls: Where a control joint occurs in an acoustical or fire rated system, blocking shall be provided behind the control joint by using a backing material such as 5/8 in. type X gypsum panel products, mineral fiber, or other tested equivalent.

D. Interior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners unless otherwise indicated.
   2. Bullnose Bead: Use where indicated.

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3. LC-Bead: Use at exposed panel edges.
4. L-Bead: Use where indicated.
5. U-Bead: Use where indicated.

E. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING GYPSUM BOARD
A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
   2. Level 2: Panels that are substrate for tile and where indicated on Drawings.
   3. Level 3: Beneath wall coverings.
   4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
      a. Primer and its application to surfaces are specified in Section 099100 "Painting."
   5. Level 5: Where indicated on Drawings.
      a. Primer and its application to surfaces are specified in Section 099100 "Painting."
E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION
A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Ceramic and porcelain tile.
      2. Stone thresholds.
      3. Crack isolation membrane.
      4. Metal edge strips.

1.3 DEFINITIONS
   A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to
      Work of this Section unless otherwise specified.
      A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI
      A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are
      contained in its "Specifications for Installation of Ceramic Tile."
   C. Module Size: Actual tile size plus joint width indicated.
   D. Face Size: Actual tile size, excluding spacer lugs, if any.

1.4 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.
      1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.5 ACTION SUBMITTALS
   A. Product Data: For each type of product including test data showing compliance with coefficient of friction
      requirement in Tile Article.
   B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of
      expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
   C. Samples for Initial Selection: For grout and accessories involving color selection.
   D. Samples for Verification:
      1. Full-size units of each type and composition of tile and for each color and finish required. For
         ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.
      2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of
         tile and for each color and finish required. Make samples at least 12 inches square, but not fewer
         than four tiles. Use grout of type and in color or colors approved for completed Work.
      3. Full-size units of each type of trim for each color and finish required.
      4. Stone thresholds in 6-inch lengths.
      5. Metal edge strips in 6-inch lengths.

1.6 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For Installer.
   B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer
      and Installer.
   C. Product Certificates: For each type of product.
   D. Product Test Reports: For tile-setting and -grouting products.
1.7 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match and are from same production runs as products installed and that are packed with protective covering for storage and identified with labels describing contents.
      1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated, but not less than one box of each color and size.
      2. Grout: Furnish one 10 lb. unopened bag of each color installed.

1.8 QUALITY ASSURANCE
   A. Installer Qualifications:
      1. Installer is a five-star member of the National Tile Contractors Association.
      2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
      3. Installer employs Ceramic Tile Education Foundation Certified Installers.
   B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
      1. Build mockup of each type of floor tile installation.
      2. Build mockup of each type of wall tile installation.
      3. 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. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
   B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
   C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
   D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS
   A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
      1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
   B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
      1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
      2. Obtain waterproof membrane and crack suppressant membranes, except for sheet products, from manufacturer of setting and grouting materials.
   C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
      1. Stone thresholds.
      2. Waterproof membrane.
      3. Crack isolation membrane.
      4. Cementitious backer units.
      5. Metal edge strips.

2.2 PRODUCTS, GENERAL
   A. VOC Limits: Adhesives, sealants, paints, or coatings shall meet the VOC limits of authority having jurisdiction.
   B. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
      1. Provide tile complying with Standard grade requirements unless otherwise indicated.
C. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

D. Field Blending: For tile exhibiting color variations within ranges, blend tile in factory to match approved Samples.

E. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

F. Dynamic Coefficient of Friction (level interior tiles that will be walked on when wet) per ANSI A137.1: DCOF (Dynamic Coefficient of Friction) of \*0.42, DCOF, per DCOF AcuTestSM method.

2.3 TILE PRODUCTS (CT)
A. Tile: As scheduled.
B. Dynamic Coefficient of Friction; DCOF: For tiles installed on walkway surfaces, provide products with the following value as determined by testing identical products per ANSI 137.1:
   1. Level Surfaces (interior when wet): Minimum \geq 0.42.

2.4 THRESHOLDS
A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
   1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.
B. Marble Thresholds: ASTM C 503/C 503M, with a minimum abrasion resistance of 10 according to ASTM C 1353 or ASTM C 241/C 241M and with honed finish.
   1. Description: Uniform, fine- to medium-grained white stone with gray veining.

2.5 CRACK ISOLATION MEMBRANE
A. General: Manufacturer’s standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Noble Company (The); Nobleseal CIS.

2.6 SETTING MATERIALS
A. Latex-Portland Cement Mortar (Thinset): ANSI A118.4.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ardex Americas.
      b. Custom Building Products.
      c. Laticrete International, Inc.
   2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
   3. Provide prepackaged, dry-mortar mix combined with acrylic resin liquid-latex additive at Project site.
   4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.7 GROUT MATERIALS (GR)
A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by MAPEI Corporation or comparable products by one of the following:
      a. Custom Building Products.
      b. Laticrete International, Inc.

2.8 MISCELLANEOUS MATERIALS
A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
B. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
2. Basis-of-Design Product: Subject to compliance with requirements, product name or designation or comparable product by one of the following:
   a. Schluter Systems L.P.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
   2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
      a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
      b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
   3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
   4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable self-leveling and patching compound specifically recommended by tile-setting material manufacturer.
   B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

3.3 CERAMIC TILE INSTALLATION
   A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
   1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
      a. Tile floors in wet areas.
      b. Tile floors consisting of tiles 8 by 8 inches or larger.
      c. Tile floors consisting of rib-backed tiles.
   B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
   C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
   D. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
   E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
      1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
      2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
   2. Pressed Floor Tile: 1/8” to 1/4”.
   4. Porcelain Tile: 1/8 to 1/4 inch.

G. Lay out tile wainscots to dimensions indicated.

H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

I. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
   1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thinset).
   2. Do not extend waterproofing under thresholds set in latex-portland cement mortar. Fill joints between such thresholds and adjoining tile set on waterproofing with elastomeric sealant.

J. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile. Refer to details on the drawings.

K. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer from tile faces by wiping with soft cloth.

3.4 TILE BACKING PANEL INSTALLATION
   A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.5 CRACK ISOLATION MEMBRANE INSTALLATION
   A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
   B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.6 ADJUSTING AND CLEANING
   A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
   B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
      1. Remove grout residue from tile as soon as possible.
      2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.7 PROTECTION
   A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
   B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
   C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.8 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE
   A. Interior Floor Installations, Concrete Subfloor:
      1. Ceramic Tile Installation: TCNA F113; thinset mortar.
      2. Ceramic Tile Installation: TCNA F125A; thinset mortar on crack isolation membrane.

B. Interior Wall Installations, Metal Studs or Furring:
   1. Ceramic Tile Installation: TCNA W243; thinset mortar on gypsum board.
   2. Ceramic Tile Installation: TCNA W245 or TCNA W248; thinset mortar on cement backer board.
      b. Grout: Standard ground.

END OF SECTION
SECTION 095113

ACOUSTICAL PANEL CEILINGS

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 acoustical panels and exposed suspension systems for ceilings.
   B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 DEFINITIONS
   A. AC: Articulation Class.
   B. CAC: Ceiling Attenuation Class.
   C. LR: Light Reflectance coefficient.
   D. NRC: Noise Reduction Coefficient.

1.4 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
   C. Samples for Initial Selection: For components with factory-applied color finishes.
   D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
      1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
      2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

1.6 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      1. Suspended ceiling components.
      2. Structural members to which suspension systems will be attached.
      3. Size and location of initial access modules for acoustical panels.
      4. Items penetrating finished ceiling including the following:
         a. Lighting fixtures.
         b. Air outlets and inlets.
         c. Speakers.
         d. Sprinklers.
         e. Access panels.
      5. Perimeter moldings.
   B. Qualification Data: For testing agency.
   C. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.
   D. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

1.7 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For finishes to include in maintenance manuals.
1.8 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for
      storage and identified with labels describing contents.
      1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed. 5 unopened
         boxes of each type and size in unopened packages from same production run as installed in the
         project.
      2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of
         quantity installed.
      3. Hold-Down Clips: Equal to 2 percent of quantity installed.
      4. Impact Clips: Equal to 2 percent of quantity installed.

1.9 QUALITY ASSURANCE
   A. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic
      effects and set quality standards for materials and execution.
      1. Build mockup of typical ceiling area as shown on Drawings.
      2. Subject to compliance with requirements, approved mockups may become part of the completed
         Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING
   A. Deliver acoustical panels, suspension-system components, and accessories not in contact with floor slab
      to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where
      they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight,
      surface contamination, and other causes.
   B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture
      content.
   C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.11 FIELD CONDITIONS
   A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and
      weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient
      temperature and humidity conditions are maintained at the levels indicated for Project when occupied for
      its intended use.
      1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning
         acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify
      products with appropriate markings of applicable testing agency.
      1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
      2. Smoke-Developed Index: 450 or less.
   B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify
      products with appropriate markings of applicable testing agency.
      1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another
         qualified testing agency.

2.2 ACOUSTICAL PANELS, GENERAL
   A. Source Limitations:
      1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer form one
         production run.
      2. Suspension System: Obtain each type from single source from single manufacturer.
   B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from
      single source from single manufacturer.
   C. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply
      with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light
      reflectances unless otherwise indicated.
      1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test
         specimen is 15-3/4 inches away from test surface according to ASTM E 795.

ACOUSTICAL PANEL CEILINGS
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D. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
   1. Where appearance characteristics of acoustical panels are indicated by referencing pattern
designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide
products selected by Architect from each manufacturer's full range that comply with requirements
indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL PANEL CEILINGS (AC)
A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Armstrong World Industries, Inc.
B. Acoustical Panel Size, Color and Pattern: As scheduled.
C. Acceptable products: As scheduled.
D. Substitutions: In accordance with Section 012500 “Substitution Procedures” and acceptance by the
   Architect.

2.4 METAL SUSPENSION SYSTEMS, GENERAL
A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension
systems of types, structural classifications, and finishes indicated that comply with applicable requirements
in ASTM C 635/C 635M.
   1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification
   for Severe Environment Performance" where high-humidity finishes are indicated.
B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1,
"Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
   1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for
   attaching hangers of type indicated and with capability to sustain, without failure, a load equal to
   five times that imposed by ceiling construction, as determined by testing according to ASTM E 488
   or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
   a. Type: anchors.
   b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633,
      Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
   c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F
      594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
   d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with
      ASTM B 164 for UNS No. N04400 alloy.
   2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated,
fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching
hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times
that imposed by ceiling construction, as determined by testing according to ASTM E 1190,
conducted by a qualified testing and inspecting agency.
C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M,
      Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch-
      diameter wire.
D. Hold-Down Clips: Where indicated, provide manufacturer’s standard hold-down clips spaced 24 inches
   o.c. on all cross tees.

2.5 METAL SUSPENSION SYSTEM
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
B. Subject to compliance with requirements, provide one of the following:
   1. Armstrong World Industries, Inc.
   2. Substitutions: In accordance with Section 012500 “Substitution Procedures” and acceptance by the
      Architect.
C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from
cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A
653/A 653M, not less than G30 coating designation; with prefinished 02/11-inch- wide metal caps on
flanges.
D. End Condition of Cross Runners: Override (stepped) or butt-edge type.
   1. Face Design: Flat, flush.
   2. Cap Material: Steel cold-rolled sheet.
E. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 9/16-inch- wide metal caps on flanges.
   2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
   3. Face Design: Flat, flush.

2.6 METAL EDGE MOLDINGS AND TRIM
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong World Industries, Inc.
   2. Substitutions: In accordance with Section 012500 “Substitution Procedures” and acceptance by the Architect.
B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
   1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.

2.7 ACOUSTICAL SEALANT
A. Products: Subject to compliance with requirements, provide one of the following:
   1. Acoustical Sealant for Exposed and Concealed Joints:
      a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
      b. USG Corporation; SHEETROCK Acoustical Sealant.
   2. Acoustical Sealant for Concealed Joints:
      a. Pecora Corporation; AIS-919.
B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
C. Acoustic Batts: Refer to Section 098116 “Acoustical Blanket Insulation”

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.
3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrates at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. Arrange directionally patterned acoustical panels as follows:
   a. As indicated on reflected ceiling plans.
2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.

7. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION
SECTION 096116

CONCRETE FLOOR SEALING

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:
      1. Sealing of concrete floor areas not otherwise scheduled to receive finish floor covering.
      2. Cleaning and sealing of existing concrete floors not scheduled to receive finish floor covering.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated.
      1. Include data to indicate chemical, solvent, and detergent resistance.
      2. Include information for primer, sealants, accessories and other required components.

1.4 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For fluid-applied floor sealer to include in maintenance manuals. Include the following:
      1. Manufacturer's instructions on maintenance renewal of applied treatments.
      2. Protocols and product specifications for joint filing, crack repair and/or surface repair.

1.5 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum 10 years documented experience.
   B. Installer Qualifications: An installer (applicator) who is approved, trained, or certified by fluid-applied floor sealer manufacturer.
   C. Source Limitations: Furnish products from one manufacturer for entire Project, unless otherwise acceptable to Architect.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Deliver materials in manner to prevent damage to containers and bags.
   B. Store materials in accordance with manufacturer's instructions in clean and dry location with temperature between 60 deg F and 90 deg F.
   C. Keep products away from fire or open flame.

1.7 PROJECT CONDITIONS
   A. Environmental Limitations: Comply with flooring manufacturer's written instructions for substrate temperature, ambient temperature, humidity, ventilation, and other conditions affecting flooring application.
      1. Do not apply flooring until spaces are enclosed and weatherproof; wet work in spaces is complete and dry; and overhead work, including installing mechanical systems, lighting, and athletic equipment, is complete.
   B. Conditioning Period: Begins not less than 7 days before flooring application, is continuous through application, and continues not less than 3 days after application.
      1. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.
   C. Ventilate area where flooring is being installed. Post and enforce no smoking and no open flame signs until flooring has cured.
   D. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during floor sealer application.
   E. Close spaces to traffic during floor sealer application and for not less than 24 hours after application unless manufacturer recommends a longer period.
1.8 SEQUENCING AND SCHEDULING
   A. Sequence work under provisions of Division 01 Section “Construction Progress Documentation.”

1.9 WARRANTY
   A. Prepare and submit in accordance with Sections 016100 and 017700.
   B. Provide written warranty signed by manufacturer warranting work to be free from defective materials and
      workmanship, and agreeing to replace components which fail within 2 years from date of Substantial Completion.
      1. Failed materials and workmanship includes spalling, cracking, and delamination.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the
      following:
      1. Dayton Superior Specialty Chemical Corp.
      2. L & M Construction Chemicals, Inc.
      3. Euclid Chemical.

2.2 CONCRETE FLOOR SEALER (CC)
   A. VOC Limits: Adhesives, sealants, paints, or coatings shall meet the VOC limits of authority having
      jurisdiction.
   B. Epoxy: Two component, water-based, high-performance, high-solids, epoxy floor coating system, equal to
      Euco 512 VOX.
   C. Acrylic: Super Diamond Clear VOX.

2.3 ACCESSORIES
   A. Joint Sealant Materials: Manufacturer’s recommended sealant compatible with flooring system for type of
      service and joint condition indicated.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates, with Installer (Applicator) present, for conditions affecting performance of flooring
      including substrate moisture content.
   B. Examine areas to receive flooring for:
      1. Defects in substrate that may affect proper execution of flooring work.
      2. Deviations beyond allowable tolerance for concrete slab work.
      3. Surface curing agents or sealers that would inhibit bond.
      4. Surface defects such as cracks that could transfer through to finished flooring surface if not
         corrected.
   C. Do not begin flooring work until concrete has cured a minimum of 28 days.
   D. Do not begin work until unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Prepare Substrate: Test concrete substrate for pH, contaminants, and moisture content in accordance with
      manufacturer’s recommendations. Ensure concrete is within manufacturers recommended limits prior to
      installation.
   B. Concrete Sub-floors: Verify that concrete slabs comply with ASTM F 710 and the following:
      1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that
         may interfere with adhesive bond.
      2. Mechanically abrade or shot-blast existing concrete flooring to remove inappropriate curing agents
         and to open pores of concrete surfaces to allow penetration of bonding agent. Completely remove
         cleaning residue. Acid washing is not acceptable.
      3. Repair cracks, divots and surface imperfections according to manufacturer’s instructions.
      4. Vacuum to remove dust and debris.
   C. Protect walls, floor openings, equipment, electrical openings, door frames, and other obstructions during

CONCRETE FLOOR SEALING
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installation. Cover floor and wall areas at mixing stations.

3.3 APPLICATION
A. General: Mix and apply flooring components according to manufacturer’s written instructions.
B. Apply a minimum of 2 coats in accordance with manufacturer’s recommended coverage rates.

3.4 CURING
A. Cure flooring materials according to manufacturer's directions, taking care to prevent contamination during application stages and before completing curing process.
   1. Indoor Air Quality Procedures: Ventilate in accordance with Division 01 Section “Environmental Project Procedures.”

3.5 CLEANING AND PROTECTION
A. Clean as recommended by manufacturer. Do not use materials or methods which may damage surface or surrounding construction.
   1. Cleaner, Maximum VOC Content: In accordance with applicable codes.
B. Remove temporary covering and clean flooring prior to final inspection. Use cleaning materials and procedures recommended by flooring manufacturer.
C. Protect finished work in accordance with Division 01 Section “Common Execution Requirements.”
D. Do not permit traffic over finished flooring surfaces.
E. Protect flooring materials from damage and wear during construction operation.

END OF SECTION
SECTION 096513
RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Resilient base.
      2. Resilient molding accessories.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches
      long.
   C. Samples for Initial Selection: For each type of product indicated.
   D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern
      required in manufacturer's standard-size Samples, but not less than 12 inches long.
   E. Product Schedule: For resilient base and accessory products. Use same designations indicated on
      Drawings.

1.4 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. Furnish not less than 10 linear feet for every 500 linear feet
         or fraction thereof, of each type, color,
         pattern, and size of resilient product installed from same production run as product installed on
         project.

1.5 QUALITY ASSURANCE
   A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic
      effects and set quality standards for materials and execution.
      1. Coordinate mockups in this Section with mockups specified in other Sections.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient
      temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more
      than 90 deg F.

1.7 FIELD CONDITIONS
   A. Maintain ambient temperatures and humidity within range recommended by manufacturer, but not less
      than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time
      periods:
      1. 48 hours before installation.
      2. During installation.
      3. 48 hours after installation.
   B. After installation and until Substantial Completion, maintain ambient temperatures within range
      recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
   C. Install resilient products after other finishing operations, including painting, have been completed.
   D. Ensure slab moisture content is within manufacturer's acceptable levels.
PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE (RB)
   A. Basis of Design Manufacturer: Subject to compliance with requirements, provide products by Johnsonite; a Tarkett company.
      1. Substitutions: Submit in accordance with Section 012500 “Substitution Procedures”.
   B. Product Standard: Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
      1. Group: I (solid, homogeneous) or II (layered).
      2. Style and Location:
         a. Style D, Sculptured:
            1) Profile: As scheduled.
   C. Thickness: As standard for Manufacturer.
   D. Height: As indicated on Drawings.
   E. Lengths: As standard for Manufacturer.
   F. Outside Corners: Job formed.
   G. Inside Corners: Job formed.
   H. Colors: As scheduled.

2.2 RUBBER MOLDING ACCESSORY
   A. Manufacturers: Subject to compliance with requirements, provide products by Johnsonite; a Tarkett company.
      1. Substitutions: Submit in accordance with Section 012500 “Substitution Procedures”.
   B. Description: Rubber transition for tile carpet and resilient flooring
   C. Profile and Dimensions: As indicated.
   D. Locations: Provide rubber molding accessories in areas indicated.
   E. Colors and Patterns: As scheduled.

2.3 INSTALLATION MATERIALS
   A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
   B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
      1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.
      1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION
   A. Prepare substrates according to manufacturer’s written instructions to ensure adhesion of resilient products.
   B. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION
   A. Comply with manufacturer's written instructions for installing resilient base.
   B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
   C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
   D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

RESILIENT BASE AND ACCESSORIES
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E. Do not stretch resilient base during installation.
F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
G. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
      a. Form without producing discoloration (whitening) at bends.
   2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
      a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION
A. Comply with manufacturer's written instructions for installing resilient accessories.
B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION
A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
B. Perform the following operations immediately after completing resilient-product installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Vacuum surfaces thoroughly.
C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
D. Cover resilient products subject to wear until Substantial Completion.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Floating resilient plank floor tile.
2. Surface preparation.
3. Installation requirements.

1.3 SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
   1. Show details of special patterns.
C. Samples: Full-size units of each color and pattern of floor tile required.
D. Samples for Initial Selection: For each type of floor tile indicated.
E. Samples for Verification: Full-size units of each color and pattern of floor tile required.
F. Qualification Data: For Installer.
G. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.4 MAINTENANCE MATERIALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Floor Tile: Furnish one box for every 10 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation.
B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockups for floor tile including accessories.
      a. Size: Minimum 100 sq. ft. for each type, color, and pattern.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents unless specifically approved in writing.

1.6 DELIVERY, STORAGE, AND FIELD CONDITIONS
A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 degrees Fahrenheit, for 24 to 48 hours before installation. Stack cartons no more than 3 high with at least 4 inches of airflow around not next to and heat or cooling ducts and direct sunlight.

1.7 FIELD CONDITIONS
A. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 60 deg F or more than 90 deg F.
B. Close spaces to traffic during floor tile installation.
C. Close spaces to traffic for 24 hours after floor tile installation.
D. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
1. Critical Radiant Flux Classification: Class I, not less than 1.0 W/sq. cm.

B. FloorScore Compliance: Resilient tile flooring shall comply with requirements of FloorScore certification.

C. Static Load Limit: Passes modified weight 1,000 psi as per ASTM F970.

D. Coefficient of Friction: Passes >0.6 as per ASTM D2047 and meets and exceeds ADA requirements.

E. Abrasion Resistance: Passes using 2 H-18, 1000g weighted wheels at 5000 cycles with minimum affect no signs of wear through as per ASTM D-3884.

F. Acoustical Performance:
   1. Acoustical Testing Elevations over 6 inches thick concrete with drop ceiling per ASTM E492 IIC
   2. Elevations over 6 inches thick concrete per ASTM E2179 Delta IIC - 18

G. Low-Emitting Materials: Flooring system shall comply with the testing and product requirements of the California Department of Public Health’s “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers.”

2.2 FLOATING RESILIENT PLANK FLOOR TILE (RT)

A. Products: Subject to compliance with requirements, provide the following:
   1. As scheduled.

B. Standard: ASTM F 1700.
   2. Type: B, embossed surface.

C. Thickness: 5.0 mm total.

D. Size: As scheduled.

E. Construction includes fiberglass sheet for dimensional stability

F. Colors and Patterns: As scheduled.

2.3 INSTALLATION MATERIALS

A. Trowelable, Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

B. Adhesives: R88 Gravity Grip Spray Locking Adhesive.
   1. Adhesives shall have the following limits for VOC content: 50 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Any tile or sheet that is of a soft cushion construction must be removed.

B. Examine substrates, with installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
   1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to floor tile manufacturer’s written instructions to ensure adhesion of resilient products.
   1. For all removal of any resilient glue down product follow RFCI’s recommended Work Practices for removal of resilient floor covering. Do not sand or bead blast during removal.

B. Concrete Substrates: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer.
   4. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
   5. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer’s written recommendations, but not less stringent than the following:
      a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 8 lb of water/1000 sq. ft. in 24 hours.
b. Perform relative humidity test using in situ probes according to ASTM F 2170.
c. Proceed with installation only after substrates have a maximum 90 percent relative humidity level.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
1. Concrete and wood subfloors should be flat within 3/16 inch in 10 feet.

D. Do not install floor tiles until they are the same temperature as the space where they are to be installed.
1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 RESILIENT PLANK FLOOR TILE INSTALLATION

A. Comply with manufacturer’s written instructions for installing floor tile.
B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
1. Measure out room and determine the length and width of the perimeter plank or tile keeping a balanced perimeter row on each side of the room.
2. Avoid small perimeter pieces less than 6 inches in length and 3 inches in width. Check the walls and make sure it is square to the opposite wall if not you can scribe the plank or tile on the edge that goes against the wall to create a straight square-starting row. Never expose scribe or cut ends they should always be covered by molding.
3. Installation should start at corner of the room and work your way out. The perimeter needs to be secured for all installations to lock remainder of floor in place. Glue the whole perimeter using a Pressure Sensitive Adhesive as recommended by Gravity Grip Stay adhesive manufacturer.
4. Create at least a 10-inch perimeter in width for planks and 14-inch perimeter in width for 12” x 24” tiles including all walkway entrances and under heavy appliances and furniture.
5. Leave an expansion space from wall at least 1/8 inch covered by molding.
6. Plank Installation
   a. Stagger the rows with different size planks so the ends of the planks do not line up in a straight uniform line. No starting row piece or end piece should be less than 6 inches and a random staggered method is best.

C. Match floor tiles for color and pattern by selecting tiles and planks working out of a minimum of 3 boxes and mix planks or tiles. Discard broken, cracked, chipped, or deformed units.
D. Scribe, cut, and fit floor tiles and planks to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
E. Extend floor tiles and planks into toe spaces, door reveals, closets, and similar openings.
F. Extend floor tiles to center of door openings.
G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on flooring as marked on substrates. Use chalk or other nonpermanent marking device.
H. Adhere flooring to substrates using adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections. Apply adhesive in accordance with the adhesive and flooring manufacturer’s instructions and following tile installation instructions specified herein.
1. For large open rooms with perimeter walls longer than 15 feet add an additional strip of adhesive perpendicular and centered to the perimeter wall to create an adhesive grid to lock flooring in place.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer’s written instructions for cleaning and protecting floor tile.
B. Perform the following operations immediately after completing flooring installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.
C. Protect flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
D. Cover floor tile until Substantial Completion.

END OF SECTION
SECTION 096813
TILE CARPETING

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 modular, fusion-bonded tufted carpet tile.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
      2. Include installation recommendations for each type of substrate.
   B. Shop Drawings: Show the following:
      1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are
         required in carpet tiles.
      2. Carpet tile type, color, and dye lot.
      3. Type of subfloor.
      4. Type of installation.
      5. Pattern of installation.
      6. Pattern type, location, and direction.
      7. Pile direction.
      8. Type, color, and location of insets and borders.
      9. Type, color, and location of edge, transition, and other accessory strips.
     10. Transition details to other flooring materials.
   C. Samples: For each of the following products and for each color and texture required. Label each Sample
       with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and
       in schedules.
      2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch-long Samples.
   D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For Installer.
   B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
   C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
      1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures
         and manufacturer's recommended maintenance schedule.
      2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 QUALITY ASSURANCE
   A. Installer Qualifications: An experienced installer who is certified by the International Certified
      Floorcovering Installers Association at the Commercial II certification level.
   B. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested
      for fire response according to NFPA 253 by a qualified testing agency.
   C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic
      effects and set quality standards for fabrication and installation.
      1. Build mockups at locations and in sizes shown on Drawings.
      2. Subject to compliance with requirements, approved mockups may become part of the completed
         Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Comply with CRI 104 including:
1. ASTM F710 – Standard practice for preparing concrete to receive resilient flooring.
3. ASTM F2170 – In-situ relative humidity testing.

1.8 FIELD CONDITIONS
A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.
B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.9 WARRANTY
A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
3. Warranty Period: 10 years from date of Substantial Completion.

1.10 ATTIC STOCK
A. Provide not less than 3% of material from the same production run as used in the project. For the field tile(s) provide unopened packages round up to the nearest full package. Store in location determined by Owner.

PART 2 - PRODUCTS

2.1 CARPET TILE (C), (EM)
A. Products: As scheduled.

2.2 INSTALLATION ACCESSORIES
A. Self-Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
B. Adhesives: Water-resistant, mildew-resistant, non-staining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
C. Metal Edge/Transition Strips: Extruded aluminum with clear anodized finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.
B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
2. Subfloor finishes comply with requirements specified in Division 03 Section “Cast-in-Place Concrete” for slabs receiving carpet tile.
3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION
   A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
   B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
   C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
   D. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
   E. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

3.3 INSTALLATION
   A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
   B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
   C. Maintain dye lot integrity. Do not mix dye lots in same area.
   D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
   E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
   F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, non-staining marking device.
   G. Install pattern parallel to walls and borders.
   H. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION
   A. Perform the following operations immediately after installing carpet tile:
      1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
      2. Remove yarns that protrude from carpet tile surface.
   B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protecting Indoor Installations."
   C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Wall covering.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.
B. Samples for Initial Selection: For each type of wall covering indicated.
C. Product Schedule: For wall coverings. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE
A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Surface-Burning Characteristics: As follows, per ASTM E 84:
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 50 or less.
   3. Fire-Growth Contribution: Textile wall coverings tested according to NFPA 265 and complying with test protocol and criteria in the 2003 IBC.
B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups for each type of wall covering on each substrate required. Comply with requirements in ASTM F 1141.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 PROJECT CONDITIONS
A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   1. Wood-Veneer Wall Coverings: Condition spaces for not less than 48 hours before installation.
B. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.
C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

1.6 EXTRA MATERIALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Wall-Covering Materials: For each type, full-size units equal to 3 percent of amount installed.

PART 2 - PRODUCTS

2.1 WALL COVERINGS (WC)
A. General: Provide rolls of each type of wall covering from same print run or dye lot.
B. Manufacturer’s: Subject to compliance with requirements, provide scheduled
   1. Acceptable Products: As scheduled.
2. Substitutions: Submit in accordance with Section 012500 “Substitution Procedures”.

2.2 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining, strippable adhesive, for use with specific wall covering and substrate application; as recommended in writing by wall-covering manufacturer and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Primer/Sealer: Mildew resistant, complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall-covering manufacturer for intended substrate.

C. Seam Tape: As recommended in writing by wall-covering manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Comply with manufacturer’s written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.

1. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.

2. Painted Surfaces: Treat areas susceptible to pigment bleeding.

D. Check painted surfaces for pigment bleeding. Sand gloss, semi-gloss, and eggshell finish with fine sandpaper.

E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 INSTALLATION

A. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.

B. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

D. Install reversing every other strip.

E. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.

F. Match pattern 72 inches 1830 mm above the finish floor.

G. Install seams vertical and plumb at least 6 inches 150 mm from outside corners and 3 inches 75 mm from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.

H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

I. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.

3.4 CLEANING

A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION
SECTION 098116

ACOUSTICAL BLANKET INSULATION

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following:
1. Concealed building acoustic insulation.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE
A. Source Limitations: Obtain each type of building insulation through one source.
B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 PRODUCTS GENERAL
A. VOC Limits: any adhesives, sealants, paints, or coatings shall meet the VOC limits acceptable to local Authority Having Jurisdiction.

2.2 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Glass-Fiber Insulation:
   a. CertainTeed Corporation.
   c. Owens Corning.
2. Slag-Wool-/Rock-Wool-Fiber Insulation:
   a. Fibrex Insulations Inc.
   b. Owens Corning.
   c. Thermafiber.
B. Substitutions: In accordance with Section 012500 “Substitution Procedures”.

ACOUSTICAL BLANKET INSULATION
098116 - 1
2.3 INSULATING MATERIALS
   A. General: Provide insulating materials that comply with requirements and with referenced standards.
      1. Preformed Units: Sizes to fit applications indicated; selected from manufacturer’s standard
         thicknesses, widths, and lengths.
   B. Unfaced Mineral-Fiber Blanket Insulation (in walls): ASTM C 665, Type I (blankets without membrane
      facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-
      developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
   C. Unfaced, Flexible Glass-Fiber Board Insulation (above ceilings): ASTM C 612, Type IA; ASTM C 553,
      Types I, II, and III; or ASTM C 665, Type I; with maximum flame-spread and smoke-developed indices of
      25 and 50, respectively; and of the following properties:
      1. Nominal density of not less than 1.5 lb/cu. ft. nor more than 1.7 lb/cu. ft., thermal resistivity of 4 deg
         F x h x sq. ft./Btu x in. at 75 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates and conditions, with Installer present, for compliance with requirements for Sections in
      which substrates and related work are specified and other conditions affecting performance.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Clean substrates of substances harmful to insulations or vapor retarders, including removing projections
      capable of puncturing vapor retarders or of interfering with insulation attachment.

3.3 INSTALLATION, GENERAL
   A. Comply with insulation manufacturer’s written instructions applicable to products and application indicated.
   B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to
      ice or snow.
   C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around
      obstructions and fill voids with insulation. Remove projections that interfere with placement.
   D. Water-Piping Coordination: If water piping is located on inside of insulated exterior walls, coordinate
      location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
   E. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown
      or required to make up total thickness.

3.4 INSTALLATION OF GENERAL BUILDING INSULATION
   A. Install mineral-fiber blankets in cavities formed by framing members according to the following
      requirements:
      1. Use blanket widths and lengths that fill the cavities formed by framing members. If more than one
         length is required to fill cavity, provide lengths that will produce a snug fit between ends.
      2. Place blankets in cavities formed by framing members to produce a friction fit between edges of
         insulation and adjoining framing members.
      3. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets
         mechanically and support faced blankets by taping stapling flanges to flanges of metal studs.
      4. Where glass-fiber blankets are indicated for sound attenuation above ceilings, install blanket
         insulation over entire ceiling area in thicknesses indicated. Extend insulation 48 inches up either
         side of partitions.

3.5 PROTECTION
   A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical
      abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse
      and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

ACOUSTICAL BLANKET INSULATION
098116 - 2
SECTION 098436

FABRIC WRAPPED ACOUSTICAL UNITS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes shop-fabricated, fabric-wrapped panel units tested for acoustical performance, including:
   1. Ceiling mounted, fabric wrapped, acoustical shapes and panels.

1.3 DEFINITIONS
A. NRC: Noise Reduction Coefficient.
B. SAA: Sound Absorption Average.

1.4 SUBMITTALS
A. Product Data: For each type of fabric facing, panel edge, core material, and mounting indicated.
B. Shop Drawings: For sound-absorbing units. Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling and wall intersections. Indicate panel edge and core materials.
   1. Include elevations showing panel sizes and direction of fabric weave and pattern matching.
C. Samples: For each type of fabric facing from sound-absorbing unit, including seams and corner conditions.
D. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Lighting fixtures.
   2. Exit light fixtures.
   3. Air outlets and inlets.
   4. Speakers.
   5. Alarms.
   7. Access panels.
   8. Show operation of hinged and sliding components covered by or adjacent to sound-absorbing units.
E. Maintenance Data: For sound-absorbing units to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal recommendations.

1.5 QUALITY ASSURANCE
A. Source Limitations: Obtain sound-absorbing units from single source from single manufacturer.
B. Fire-Test-Response Characteristics: Provide sound-absorbing units meeting the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.
   2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Comply with fabric and sound-absorbing unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.7 PROJECT CONDITIONS
A. Environmental Limitations: Do not install sound-absorbing units until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work at and above ceilings is complete, and ambient
temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Coordinate installation of integral light fixtures in accordance with manufacturer's printed installation requirements and accepted submittals. Do not install sound-absorbing units until a permanent level of lighting is provided on surfaces to receive the units.

C. Air-Quality Limitations: Protect sound-absorbing units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify locations of sound-absorbing units and actual dimensions of openings and penetrations by field measurements before fabrication.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sound-absorbing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to the following:
   b. Fabric sagging, distorting, or releasing from panel edge.
   c. Warping of core.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FABRIC WRAPPED ACOUSTIC PANELS (AP)

A. Basis of Design: As scheduled.

B. Fabric Wrapped, Suspended or Surface Mounted Acoustic Panels: Manufacturer's standard panel construction consisting of fabric facing material laminated to exposed faces, edges and perimeter of core.

1. Mounting: Pendant or face mounted with splines secured to substrate.
   a. Finish Color at Exposed Edges: As scheduled.

2. Mounting: Pendant or back mounted with manufacturer's standard hardware, secured to substrate.

3. Core: Glass-fiber board.

4. Edge Construction: Manufacturer's standard chemically hardened core with no frame.

5. Edge Profile: Long edges kerfed and rabbeted to receive splines.

6. Corner Detail in Elevation: Lapped square with continuous edge profile.

7. Acoustical Performance: Sound absorption NRC of not less than 1.05.

8. Nominal Overall Panel Thickness: As indicated on Drawings.

9. Panel Width: As indicated on Drawings.

10. Panel Height: As indicated on Drawings.

2.2 MATERIALS

A. Core Materials:

1. Glass-Fiber Board: ASTM C 612, Type standard with manufacturer; nominal density of 6 to 7 lb/cu. ft. 96, unfaced, (unless otherwise indicated on Master Schedule) and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

B. Facing Material: Fabric from same dye lot; color and pattern as indicated on Drawings.

1. Manufacturer, Product Line/Pattern, Style Number, Color: As scheduled.

C. Mounting Devices: Concealed on unit, recommended by manufacturer to support weight of unit, and as follows:

1. Splines: Manufacturer's standard concealed metal or plastic splines that engage the kerfed edges of the unit, with other moldings and trim for interior corners, exterior corners, and exposed edges, with factory-applied finish on exposed items.

2.3 FABRICATION

A. General: Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

1. Glass-Fiber Board Cores: Chemically harden core edges and areas of core where mounting devices are attached.

B. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.
C. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.
   1. Square Corners: Tailor corners.
   2. Radius and Other Non-Square Corners: Attach facing material so there are no seams or gathering of material.
   3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

D. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:
   1. Thickness.
   2. Edge straightness.
   3. Overall length and width.
   4. Squareness from corner to corner.
   5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine fabric, fabricated units, substrates, areas, and conditions, for compliance with requirements, installation tolerances, and other conditions affecting performance of sound-absorbing units.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Install sound-absorbing units in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
   B. Comply with sound-absorbing unit manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
   C. Align and level fabric pattern and grain among adjacent units.

3.3 INSTALLATION TOLERANCES
   A. Variation from Plumb and Level: Plus or minus 1/16 inch.
   B. Variation of Panel Joints from Hairline: Not more than 1/16 inch wide.

3.4 CLEANING
   A. Clip loose threads; remove pills and extraneous materials.
   B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION
SECTION 099100

PAINTING

PART 1 - GENERAL

1.1 SUMMARY
   A. Related Documents: General and Supplementary Conditions of the Contract, Division 01 General
      Requirements, and Drawings are applicable to this Section.
   B. Section Includes:
      1. Complete surface preparation and finishing for field application of coatings and requirements for
         field finishing mechanical and electrical equipment.
      2. Examine specifications for various other trades and their provisions regarding their painting.
         Surfaces that are left unfinished by other sections of the specifications shall be painted or finished
         as a part of this Section.
      3. Colors, including deep tones, will be selected by the Architect. Number of colors to be used on job
         will be determined by Architect.

1.2 SURFACES NOT TO RECEIVE FIELD FINISHING
   A. Do not paint copper, bronze, chrome plated items, nickel, stainless steel, Monel metal, lead, face brick,
      prefinished wall, ceiling, and floor coverings, items with factory applied final finish (except where exposed
      on roofs and in finished spaces), elevator shafts, crawl spaces, chases, and plenums above suspended
      ceilings unless otherwise specified or scheduled.

1.3 DEFINITIONS
   A. Conform to ASTM D16 for interpretation of terms used in this Section.

1.4 QUALITY ASSURANCE
   A. Product Manufacturer: Company specializing in manufacturing quality paint and finish products with 3
      years' experience.
   B. Applicator: Company specializing in commercial painting and finishing with 2 years' experience.
   C. Product Labels: Include manufacturer's name, type of paint, stock number, color and label analysis on
      label of containers.

1.5 REGULATORY REQUIREMENTS
   A. Conform to applicable building code for flame spread/fuel contribution/smoke development rating
      requirements for finishes.
   B. Comply with applicable city, county, state, and federal requirements and ordinances regarding maximum
      VOC (Volatile Organic Compound) content of all coatings.

1.6 TESTS
   A. Provide periodic testing with Wet Film Thickness gage to verify that proper thickness of finish coatings are
      being applied.

1.7 SUBMITTALS
   A. Provide product data describing physical performance criteria and composition on all finishing products.
   B. Submit 2 samples, 12 by 12 inches in size illustrating range of colors and textures selected for each
      surface finishing product scheduled.
   C. Submit certification from manufacturer of coatings listing all products proposed for each. Certify that each
      product meets current applicable regulations and ordinances regarding maximum VOC content.

1.8 FIELD SAMPLES
   A. Provide field sample panel, 96 inches long by 96 inches wide, illustrating each coating color, texture, and
      finish intended for use.
   B. Locate where directed.
   C. Accepted sample may remain as part of the Work.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Deliver, store, and protect products under provisions of Division 01 section “Product Requirements”
B. Deliver products to site in sealed and labeled containers; inspect to verify acceptance.
C. Container labeling to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, and instructions for mixing and reducing.
D. Store paint materials at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in well-ventilated area, unless required otherwise by manufacturer's instructions.
E. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.10 ENVIRONMENTAL REQUIREMENTS
A. Do not apply materials when surface and ambient temperatures are outside the ranges required by paint manufacturer.
B. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45 degrees F for 24 hours before, during, and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.
C. Do not apply exterior coatings during rain or snow, or when relative humidity is above 75 percent, unless required otherwise by manufacturer's instructions.
D. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
E. Minimum Application Temperature for Varnish and Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.
F. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.11 EXTRA STOCK
A. Provide a 5 gallon container of each color to Owner.
B. Label each container with color, color number, texture, and room locations, in addition to the manufacturer's label.
C. Furnish under provisions of Section 017800.

1.12 SCAFFOLDS AND PROTECTION
A. Provide adequate safe ladders, scaffolds, and stages necessary to complete work.
B. Protect completed finish and paint work, and protect adjacent finish surfaces from paint splatter, spills and stains. Use adequate drop cloths and masking procedures during progress of work.

1.13 PRECAUTIONS
A. Do not store paints, oils, thinners and other flammable items inside the building and shall be stored in approved containers when not in actual use during the painting job. The fire hazard shall be kept at a minimum.
B. Precaution shall be taken to protect the public and construction workers during the progress of the work.
C. Furnish a temporary fire extinguisher of suitable chemicals and capacity, located near flammable materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Acceptable Manufacturers: Subject to compliance with requirements indicated, provide products of one of the following:
   3. Behr Process Corporation (Behr).
B. Materials selected for coating systems for each type surface shall be product of a single manufacturer unless otherwise specified. Secondary products such as linseed oil, turpentine and shellacs shall be first quality products of a reputable manufacturer.
C. Products specified in Schedule are those of Glidden Professional as a standard of quality unless otherwise noted.

2.2 MATERIALS
A. VOC Limits: any adhesives, sealants, paints, or coatings shall meet the VOC limits indicated in Section 018113 "Sustainable Design Requirements."
B. Coatings: Ready mixed. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating with good flow and brushing properties; capable of drying or curing free of streaks or sags.
C. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.

2.3 FINISHES
A. Color and Sheen: As scheduled.

2.1 INTERIOR PAINT SCHEDULE
A. Drywall (Gypsum) (P):
1. Acrylic Latex:
   a. PPG Paints: 1 coat PPG Paints Speedhide Zero VOC Primer 6-4900XI, 2 coats PPG Paints Speedhide Zero VOC. Sheen as indicated.
   c. Behr: 1 coat Behr Premium Plus Interior Drywall Primer 73, 2 coats Behr Pro i300 Interior Paint. Sheen as indicated.

B. Doors, Trim:
1. Acrylic Latex:
   a. PPG Paints: 1 coat Speedhide Interior Latex Sealer 6-2, 2 coats PPG Paints Speedhide Zero VOC. Sheen as indicated.
   c. Behr: Behr Premium Plus All-In-One Primer & Sealer 75, 2 coats Behr Pro i300 Interior Paint. Sheen as indicated.

2. Alkyd:
   a. PPG Paints: 1 coat Speedhide Interior Latex Sealer 6-2, 2 coats Speedhide Waterbased Satin or Semi-Gloss Alkyd 6-1410/1510.
   c. Behr: Behr Premium Plus All-In-One Primer & Sealer 75, 2 coats Behr Alkyd Semi-Gloss Enamel 3900.

3. Polyurethane Varnish:
   a. PPG Paints: 1 coat DEFT Interior Oil Stain DFT400, 2 coats DEFT Interior Polyurethane Satin 450 DFT226.

C. CMU, Concrete Block:
1. Acrylic Latex:
   a. PPG Paints: 1 coat PPG Paints Speedhide Block Filler 6-15 primer, 2 coats PPG Paints Speedhide Zero VOC. Sheen as indicated.
   c. Behr: 1 coat Behr Pro Block Filler primer 50, 2 coats Behr Pro i300 Interior Paint. Sheen as indicated.

D. Galvanized Metal:
1. High Performance Coating, Water Based Acrylic
   a. PPG Paints: 1 coat DEVFLEX Direct-to-Metal 4020 primer
      1) Flat: 2 Coats DEVLFEX 4020 Primer/Finish.
      2) Eggshell: 2 coats DEVFLEX High Performance WB Acrylic 4212 topcoat.
      3) Semi-Gloss: 2 coats DEVFLEX High Performance WB Acrylic 4216 topcoat.
   b. Sherwin-Williams:
      1) Flat: 2 coats Sherwin-Williams Pro-Cryl Universal Primer B66-310 Series,
   c. Behr: 1 coat Behr Premium Plus Multi-Surface Primer & Sealer 436.
      1) Flat: 2 coats Premium Plus Ultra Interior Matte 1750 topcoat.
      2) Eggshell: 2 coats Premium Plus Ultra Eggshell 2750 topcoat.
      3) Semi-Gloss: 2 coats Direct To Metal Semi-Gloss 3200 topcoat.
E.  Shop Primed Ferrous Metal (PM):
   1. High Performance Coating, Water-Based Acrylic:
      b. Sherwin-Williams Pro Industrial Eg-Shel B66-660 Series.
   2. Acrylic Latex
      a. PPG Paints: 1 coat DEVFLEX Direct-to-Metal 4020 primer, 2 coats Speedhide Zero VOC Eggshell 6-4310XI.
      c. Behr: 1 coat Behr Premium Plus Multi-Surface Primer & Sealer 436, 2 coats Behr Pro i300 Interior Eggshell 330.

F.  Handrails, Stairs, and Guardrails:
   1. High Performance Coating, Urethane:
      a. PPG Paints: 1 coat DEVFLEX Direct-to-Metal 4020 primer, 2 coats Devguard Rust Preventative Alkyd Enamel Semi-Gloss 4306.

G.  Machinery, Equipment and Fixtures (Shop Primed):
   1. High Performance Coating, Alkyd Industrial Enamel:
      a. PPG Paints: 2 topcoats 7 Line Interior/Exterior Industrial Gloss Oil 7-282 over prepared substrate.

H.  Decking (Pre-primed/Prefinished), Bar Joists (Shop Primed) (ES):
   1. Water-Based Acrylic Dry Fall:
      a. PPG Paints: 2 topcoats Speedhide Super Tech WB Dry Fall Flat 6-725XI over prepared substrate.
      c. Behr: 2 coats Behr Pro Dryfall 890 over prepared substrate.

2.2  EXTERIOR PAINT SCHEDULE

A.  Poured Concrete, Brick:
   1. 100 Percent Acrylic Latex:
      a. PPG Paints: 1 coat Perma-Crete Int/Ext Alkali Resistant Primer 4-603
         1) Flat: 2 coats Speedhide Exterior 100% Acrylic Latex Flat 6-610XItopcoat.
         2) Satin: 2 coats Speedhide Exterior 100% Acrylic Latex Satin 6-2045XI topcoat.
         4) Gloss: 2 coats Speedhide Exterior 100% Acrylic Gloss 6-8534 topcoat.
      b. Sherwin-Williams: 1 coat Loxon Acrylic Concrete & Masonry Primer A24W8300
         1) Flat: 2 coats Sherwin-Williams A-100 Flat A6-100 Series topcoat.
         2) Satin: 2 coats of Sherwin-Williams A-100 Satin A82-100 Series topcoat.
         3) Gloss: 2 coats of Sherwin-Williams Solo Gloss A77W51 topcoat.
      c. Behr: 1 coat Behr Premium Plus Multi-Surface Primer & Sealer 436.
         1) Flat: 2 coats Behr Pro e600 Exterior Flat 610 topcoat.
         2) Satin: 2 coats Behr Pro e600 Exterior Satin 640 topcoat.
         3) Semi-Gloss: Behr Pro e600 Exterior Semi-Gloss 670 topcoat.
         4) Gloss: 2 coats Behr Premium Plus Hi-Gloss Enamel 8050 topcoat.

B.  CMU, Block:
   1. 100 Percent Acrylic Latex:
      a. PPG Paints: 1 coat Speedhide Masonry Hi Fill Latex Block Filler 6-15
         1) Flat: 2 coats Speedhide Exterior 100% Acrylic Latex Flat 6-610XItopcoat.
         2) Satin: 2 coats Speedhide Exterior 100% Acrylic Latex Satin 6-2045XI topcoat.
4. Gloss: 2 coats Speedhide Int/Ext 100% Acrylic Gloss 6-8534 topcoat.
   b. Sherwin-Williams: 1 coat PrepRite Block Filler B25W25
      1) Flat: 2 coats Sherwin-Williams A-100 Flat A6-100 Series topcoat.
      2) Satin: 2 coats of Sherwin-Williams A-100 Satin A82-100 Series topcoat.
      3) Gloss: 2 coats of Sherwin-Williams Solo Gloss A77W51 topcoat.
   c. Behr: 1 coat Behr Pro Block Filler Primer 50
      1) Flat: 2 coats Behr Pro e600 Exterior Flat 610 topcoat.
      2) Satin: 2 coats Behr Pro e600 Exterior Satin 640 topcoat.
      3) Semi-Gloss: Behr Pro e600 Exterior Semi-Gloss 670 topcoat.
      4) Gloss: Behr Premium Plus Hi-Gloss Enamel 8050 topcoat.
   C. Structural Iron and Ferrous Steel:
      1. Urethane High Performance Coating, :
         a. PPG Paints: 1 coat Pitt-Guard Direct-To-Rust Epoxy Mastic Coatings 97-145, 2 coats
            Pitthane High Build Semi Gloss Urethane Enamel 95-8800.
         b. Sherwin-Williams: 1 coat Macropoxy 646 Fast Cure Epoxy B58-600 Series, 2 coats
            3300 High Build Aliphatic Urethane Semi-Gloss topcoat.
   D. Shop Primed Metal Doors, Trim, Panels and Miscellaneous Surfaces:
      1. High Performance Coating, Urethane: (rust inhibitive, UV stable)
         a. PPG Paints: Gloss: 1 coat Pitt-Guard Direct-To-Rust Epoxy Mastic Coatings 97-145, 2 coats
            Pitthane Ultra Gloss Urethane 95 Series.
         b. Sherwin-Williams: 1 coat Macropoxy 646 Fast Cure Epoxy B58-600 Series, 2 coats Acrolon
            218 HS Acrylic Polyurethane B65-650 topcoat.
            3000 Aliphatic Acrylic Urethane Gloss topcoat.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify that surfaces and substrate conditions are ready to receive work as instructed by the product
      manufacturer.
   B. Examine surfaces scheduled to be finished prior to commencement of work. Report to Architect any
      condition that may potentially affect proper application.
   C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless
      moisture content of surfaces are below the following maximums
      1. Plaster and Gypsum Wallboard: 12 percent.
      2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
      5. Concrete Floors: 8 percent.
   D. Test shop applied primers for compatibility with subsequent cover materials.
   E. Beginning of installation means acceptance of existing surfaces and substrate.

3.2 PREPARATION
   A. Remove electrical plates, hardware, light fixture trim, and fittings prior to preparing surfaces or finishing.
   B. Correct minor defects and clean surfaces which affect work of this Section. Remove existing coatings
      which exhibit loose surface defects.
   C. Shellac and seal marks which may bleed through surface finishes.
   D. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach.
      Rinse with clean water and allow surface to dry.
   E. Aluminum Surfaces Scheduled for Paint Finish: Remove surface contamination by steam or high pressure
      water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following
      cleaning.
   F. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
   G. Concrete Floors: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-
      alkali balance is achieved. Allow to dry.
   H. Gypsum Board Surfaces: Latex fill minor defects. Spot prime defects after repair.
   I. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching
      primer.
J. Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

K. Plaster Surfaces: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.

L. Uncoated Steel and Iron Surfaces: Remove grease, scale, dirt, and rust. Where heavy coatings of scale are evident, remove by wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.

M. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.

N. Aluminum with Alodine Finish: Clean by lightly scuff with sandpaper. Remove all dust.

O. Interior Wood Items Scheduled to Receive Paint 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.

P. Interior Wood Items Schedule to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats.

Q. Exterior Wood Scheduled to receive Paint Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior caulking compound after prime coat has been applied.

R. Exterior Wood Scheduled to Receive Transparent Finish: Remove dust, grit, and foreign matter; seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes with tinted exterior caulking compound after sealer has been applied.

S. Shop Finished Items: Finish in accordance with AWI standards and guidelines.

T. Glue-Laminated Beams: Prior to finishing, wash surfaces with solvent, remove grease and dirt.

U. Wood and Metal Doors Scheduled for Painting: Seal top and bottom edges with primer.

3.3 SURFACE PREPARATION OF PREVIOUSLY COATED SURFACES

A. General:
1. Remove cracked and deteriorated sealants and caulking.
2. Remove chalk deposits and loose, blistered, peeling, scaling, or crazed finish to bare base material or sound substrate by scraping and sanding.
3. Wash surfaces with solution of TSP to remove wax, oil, grease, and other foreign material; rinse, and allow to dry. Exercise caution that TSP solution does not soften existing coating.
4. Abrade glossy surfaces by sanding or wiping with liquid de-glosser.
5. Remove mildew as specified above.
6. Test compatibility of existing coatings by applying new coating to small, inconspicuous area. If new coatings lift or blister existing coatings, request recommendation from Architect.
7. Apply specified primer to surfaces scheduled to receive coatings.

B. Gypsum Wallboard:
1. Fill cracks and voids with spackling compound.
2. Apply primer over bare surfaces and newly applied texture coatings.

C. Metal:
1. Remove rust from surfaces to bare metal in accordance with SP3 "Power Tool Cleaning".
2. Exercise care not to remove galvanizing.
3. Complete preparation as specified for new work.

D. Wood:
1. Fill cracks, crevices and nail holes with putty or wood filler.
2. Apply primer over bare surfaces and filler material.

3.4 PROTECTION

A. Protect elements surrounding the work of this Section from damage or disfiguration.
B. Repair damage to other surfaces caused by work of this Section.
C. Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.
D. Remove empty paint containers from site.
3.5 APPLICATION
A. The intent of these Specifications is to produce the highest quality appearance of paint and finish surfaces. Employ skilled mechanics only. The proper preparation of all surfaces will be strictly enforced and wherever finished surfaces show any defects due to improper preparation, workmanship, etc., the defects shall be removed and the work refinished at the expense of the Contractor.
B. Apply products in accordance with manufacturer's instructions. Final finish coats shall have visual evidence of solid hiding and uniform appearance, and shall be free and smooth of brush marks, streaks, sags, runs, laps, or skipped areas.
C. Do not apply finishes to surfaces that are not dry.
D. Apply each coat to uniform finish and thickness.
E. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
F. Sand lightly between coats on wood and metal items to achieve required finish.
G. Allow applied coat to dry before next coat is applied.
H. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
I. Prime back surfaces of interior and exterior woodwork scheduled to be painted with primer paint.
J. Prime back surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.
K. Edges of paint adjoining other materials or colors shall be sharp and clean with no overlapping.

3.6 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT
A. Paint all shop primed equipment. Paint shop prefinished items where exposed to view in finished spaces. In mechanical rooms, repair shop pre-finished coatings which have been scratched or otherwise damaged with identical touch-up paint. Sand prior to touching up as required.
B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
C. Paint all grilles, registers, diffusers, and speaker grilles to match adjacent wall and ceiling surfaces, except that factory pre-finished items need not be painted if installed in a suspended acoustical ceiling system where the acoustical panels match the mechanical or electrical item color.
D. In all finished spaces, prime and paint exposed pipes, conduit, boxes, ducts, hangers, brackets, collars and supports. Paint to match adjacent surfaces.
E. Repair or replace identification markings on mechanical or electrical equipment when painted accidentally.
F. Paint interior surfaces of air ducts and convectors that are visible through grilles and louvers with one coat of flat black paint, to limit of sight line. Paint dampers exposed behind louvers, grilles, and convectors to match face panels.
G. Paint all surfaces of plywood backboards for electrical and telephone equipment before installing equipment.
H. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing.
I. Paint exposed air handlers, roof ventilators, goose necks, exhaust fans and other items on the roof with 2 coats exterior enamel. Prepare surfaces in accordance with the base metal or primer as specified herein.
J. Paint concrete support bases with gray floor deck enamel.
K. Pipe hangers and other supports need not be painted except where installed in crawl spaces, where they shall be painted with a thick coat of asphaltic paint.

3.7 CLEANING/TOUCH-UP
A. As Work proceeds, promptly remove paint where spilled, splashed, or spattered.
B. During progress of Work maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.
C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers and remove daily from site.
D. Spot painting will be allowed to correct soiled or damaged paint surfaces only when touch-up spot will blend into surrounding finish and is invisible to normal viewing (as determined by the Architect). Otherwise, re-coat entire section to corners or to a visible stopping point.

3.8 V.O.C. (VOLATILE ORGANIC COMPOUND) COMPLIANCE
A. Products listed in following schedule and/or substitutes proposed for use by Contractor must be formulated to meet all applicable ordinances and regulations regarding maximum V.O.C. content. Utilize products which have been specially formulated to meet such requirements.

END OF SECTION
SECTION 099646
INTUMESCENT PAINTING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Intumescent paint for interior items and surfaces.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include printout of current "MPI Approved Products List" for each product category specified, with
         the proposed product highlighted.
   B. Samples: For each type of coating system and each color and gloss of intumescent paint finish indicated.

1.3 QUALITY ASSURANCE
   A. Mockups: Apply mockups of each paint system indicated to verify preliminary selections made under
      Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and
      execution.
      1. Architect will select one surface to represent surfaces and conditions for application of each coating
         system.
         a. Wall Surfaces: Provide samples of at least 100 sq. ft.
         b. Other Items: Architect will designate items or areas required.
      2. Final approval of color selections will be based on mockups.
         a. If preliminary color selections are not approved, apply additional mockups of additional
            colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Benjamin Moore & Co.
      2. PPG Paints.
   B. Products: Subject to compliance with requirements, provide product scheduled for the paint category
      indicated.

2.2 INTUMESCENT PAINT (PP)
   A. Surface-Burning Characteristics of Fire-Retardant Systems: As tested according to ASTM E84; testing by
      a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      1. Flame-Spread Index: 25 or less.
      2. Smoke-Developed Index: 450 or less.
   B. Material Compatibility:
      1. Materials for use within each paint system shall be compatible with one another and substrates
         indicated, under conditions of service and application as demonstrated by manufacturer, based on
         testing and field experience.
      2. For each material or coat, products and spreading rates shall be as recommended in writing by
         intumescent paint manufacturer for use on substrate indicated. Comply with requirements for fire-
         retardant coating classification and surface-burning characteristics indicated.
   C. Colors and Gloss: As scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates and conditions, with Applicator present, for compliance with manufacturer's
      requirements for surface treatments, shop-primed surfaces, maximum moisture content, and other
      conditions affecting performance of the Work.
B. Begin coating only when moisture content of wood substrate is 15 percent or less when measured with an electronic moisture meter.

C. Verify suitability of substrates, including surface conditions, and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION
A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.
B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 INSTALLATION
A. Apply intumescent paints according to manufacturer's written instructions and to comply with requirements for listing and labeling for surface-burning characteristics specified.

1. Finish doors on faces with intumescent finish. Paint tops, bottoms, and side edges with fire-inert finish.

3.4 INTERIOR INTUMESCENT PAINTING SCHEDULE
A. Wood Substrates, Wood-Based Panel Products:

1. Pigmented, Fire-Retardant, Water-Based System:
   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
   c. Topcoat:
      1) Fire-retardant coating, latex, interior, flat.
      2) Fire-retardant topcoat, latex, interior.

END OF SECTION
SECTION 101116
MARKERBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Magnetic, optically clear, ghost-free, shatterproof, dry-erase markerboards.

1.2 SCOPE
A. Furnish markerboards, manufacturer’s installation kits and accessories as necessary.

1.3 SUBMITTALS
A. Comply with Section 013300 – Submittals.
B. Product Data: Submit manufacturer’s product data, including installation instructions.
C. Samples: Submit manufacturer’s sample of markerboards, 8.5 by 11 inches.
D. Manufacturer’s Certification: Submit manufacturer’s certification that materials comply with specified requirements and are suitable for intended application.
E. Care and Cleaning Instructions: Submit manufacturer’s care and cleaning instructions.
F. Warranty Documentation: Submit manufacturer’s standard warranty.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
B. Storage and Handling Requirements:
1. Store and handle materials in accordance with manufacturer’s instructions.
2. Keep materials in manufacturer’s original, unopened containers and packaging until installation.
3. Store materials indoors in a flat, clean and dry area.
4. Protect materials during storage, handling, and installation to prevent damage.

PART 2 - PRODUCTS

2.1 MANUFACTURER
A. dek markerboards, (844.366.1545)
B. Substitutes:
1. Substitutes in accordance with Division 1 Section “Substitution Procedures” provided they meet the requirements herein.

2.2 MARKERBOARDS (MB)
A. Product Attributes:
1. Ghost-free: impervious to staining from dry-erase, wet-erase and permanent markers.
2. Weight: 2.44 lbs SF (magnetic).
3. Shatterproof.
4. Optically clear hard coating on face, permanent opaque color on back.
B. Sizes and Weights: As indicated.
C. Color
1. Custom as scheduled.
D. Surface: Does not absorb inks or stains, eliminates ghosting.
E. Corner Detail
1. Radiance
F. Edging
1. Brilliance
G. Style
1. Magnetic
H. Markerboard Orientation
1. As indicated
I. Markerboard Setting:
1. Provide manufacturer’s recommended Z-Clip setting
2. Provide manufacturer’s installation manual.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine walls to ensure they are flat, smooth and ready to receive markerboards.
B. Notify Architect of conditions that would adversely affect installation or subsequent use.
C. Do not begin installation until unacceptable conditions are corrected.

3.2 INSTALLATION
A. Install dek markerboards in accordance with manufacturer’s instructions at locations indicated on the Drawings.
B. Install markerboards level, plumb, and at the height indicated.
C. Leave manufacturer’s protective peel-coat on markerboard during the installation process. Remove peel-coat prior to usage.

3.3 CLEANING
A. Follow manufacturer’s instructions.
B. Do no use solvents, harsh chemicals, or abrasive cleaners on your dek markerboard surface.

3.4 PROTECTION
A. Protect installed markerboards from damage during construction.

END OF SECTION
SECTION 101400

SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY
A. Related Documents: Provisions established in Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.
B. Related work in other sections:
   1. Division 26; electrical power for LED backlit building identification signage.
C. Section Includes
   1. Identifying devices where shown on the Drawings complete and as specified including the following:
      a. Parking signs indicating accessible spaces.
      b. Directional and traffic signs.
      c. Projected, pin mounted, LED backlit building identification signs.
      d. Interior code required signs.
   2. Coordination for installation of signage provided by others.

1.2 SUBMITTALS
A. Product Data: Include manufacturer’s construction details relative to materials, dimensions of individual components, profiles, and finishes for each type of sign required.
B. Shop Drawings: Provide shop drawings for fabrication and erection of signs. Include plans, elevations, and large-scale sections of typical members and other components. Show anchors, accessories, layout, utility connections and installation details.
C. Samples for Verification:
   1. Physical: Submit samples of one completed sign for review and approval. Approved sample may be incorporated into Project.
   2. Color: Submit manufacturer’s standard color selection chart. Do not proceed until colors have been selected.

1.3 QUALITY ASSURANCE
A. Single-Source Responsibility: For each separate type of sign required, obtain signs from one source from a single manufacturer.
B. Manufacturer shall have a minimum of five years experience in the manufacturing of signs specified.
C. Codes and Standards:
   1. Panel signs shall have 1/32-inch raised copy and grade 2 Braille, and shall comply with all existing federal, state, and local accessibility standards.
   3. Comply with the State of Texas Accessibility Standards, 2012 edition, as administered by the Texas Department of Licensing and Regulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Acceptable Manufacturers: Subject to compliance with requirements herein, provide products from one of the following:
   4. ASI Signs, Dallas, Texas.
B. Substitutions: Under provisions of Section 012500.
2.2 HANDICAPPED PARKING
A. Screen Printed Signs:
   1. 18 gauge bonderized steel with blue baked enamel finish and white screen printed copy.
   2. Copy and Size:
      a. "Handicapped Parking Only" - 12 inches by 18 inches.
      b. "Van Accessible" - 12 inches by 6 inches.
   3. Acceptable Product: Best Traffic Signs No. SS04 with SS52 as required.
B. Post: Galvanized pipe column minimum 9 feet long.

2.3 DIRECTIONAL SIGNS
A. Screen Printed Signs:
   1. Extruded aluminum panels with anodic finish and white, screen printed copy.
   2. Size and Configuration: As indicated on Drawings.
   3. Copy: As indicated on Drawings.

2.4 BUILDING IDENTIFICATION SIGNAGE
A. Acceptable Manufacturers:
   1. ASI Sign Systems, 3890 W. Northwest Highway, Suite 102, Dallas, TX 75220; (214) 352 9140
      telephone; (214) 352 9741 facsimile; (800) ASI-SPEC (274-7446).
      a. Substitutions: Submit in accordance with Section 012500 “Substitution Procedures”.
B. Material:
   1. Cast Aluminum with LED lighting (“Halo-Lit”) as indicated on the Drawings.
   2. Finish: Manufacturer’s standard powder coated finish; Color: Match architect’s sample.
C. Fabricated Letters:
   1. Letter Style: Refer to Drawings.
   2. Letter Cap Height: Refer to Drawings.
   3. Letter Depth: 1 inch.
   4. Locations: As indicated on the Drawings.

2.5 POST-AND-PANEL SIGNS
A. Panel Sign: Single-panel configuration as indicated; with smooth, uniform surfaces and support assembly;
   with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles;
   and as follows:
B. Acceptable Manufacturer:
   1. ASI Sign Systems, 3890 W. Northwest Highway, Suite 102, Dallas, TX 75220; (214) 352 9140
      telephone; (214) 352 9741 facsimile; (800) ASI-SPEC (274-7446).
      a. Substitutions: Submit in accordance with Section 012500.
   2. Illuminated Sign: Backlighted construction with fluorescent tube lighting including transformers,
      insulators, and other accessories for operability, with provision for servicing and concealing
      connections to building electrical system. Use tight or sealed joint construction to prevent
      unintentional light leakage. Space lamps apart from each other and away from sign surfaces as
      needed to illuminate evenly.

2.6 ROOM SIGNAGE SYSTEMS
A. Acceptable Manufacturers:
   1. ASI Sign Systems, 3890 W. Northwest Highway, Suite 102, Dallas, TX 75220; (214) 352 9140
      telephone; (214) 352 9741 facsimile; (800) ASI-SPEC (274-7446).
   2. Acceptable Product: ASI Unframed SP Series Signs with requirements indicated for materials,
      thickness, finish colors, designs, shapes, sizes and details.
      a. Substitutions: Submit in accordance with Section 012500.
B. Sign Face: Clear acrylic, 0.080 inch thick, matte first surface.
C. Tactile Graphics and Text:
   1. Fabrication: Provide tactile copy and grade 2 Braille raised 1/32 inch minimum from plaque first
      surface by manufacturer’s stratification process as follows:
      a. ASI Intouch™, photo-mechanical method.
   2. Provide lettering and graphics precisely formed, uniformly opaque to comply with relevant ADA
      regulations and requirements indicated for size, style, spacing, content, position, and colors.
D. Non-Tactile Graphics and Text:
   1. Fabrication options:
   2. Text or graphic technique:
      a. Screen process using subsurface method.
   3. Provide lettering and graphics precisely formed, uniformly opaque, and consistent in size, style, spacing, content, position, and colors.

E. Overall panel size: Refer to Drawings.
F. Panel colors: As selected by Architect.
G. Text or graphic colors: As selected by Architect.
H. Letter styles, colors, letter sizes and layout position: As selected by Architect.
I. Installation Method: System SA, silicone adhesive

PART 3 - EXECUTION

3.1 DELIVERY AND STORAGE
A. Deliver and store identifying devices in protective wrappings until ready for installation. Install letters in protective wrappings and remove wrappings just prior to substantial completion.

3.2 INSTALLATION
A. Install signs plumb, level and square and in proper planes with other work, at heights required by accessibility codes and standards.
B. Anchor each plastic laminate sign with adhesive.
C. Install signs with sufficient amount of foam tape for proper installation.
D. Attach as recommended by sign manufacturer.
E. Anchor each sign with adhesive.
F. Coordinate arrival and installation of graphic signs with hardware installation. Graphic signs function as and are coordinated with the hardware as shown on the Drawings.
G. Room name signs shall be placed on the public side of the door except where noted otherwise.
H. Single Door Sign: Provide one sign as specified above, mounted to wall adjacent to door on knob side.
I. Pair of Doors: Provide one sign as specified above, mounted to adjacent wall closest to active leaf of door. Do not install sign where it will be obstructed by door when door is in the ‘open’ position.
J. Attachment: Mounting to surfaces shall be done by pressure sensitive frame double-faced tape. Signs shall be delivered to the project site with the tape in place and trimmed on each sign, but with the protective paper layer not removed. Paper layer shall be removed just prior to installation of signs.

3.3 EXTERIOR INSTALLATION - PARKING AND DIRECTIONAL SIGNS
A. Mount posts in 12 inch round by 2'-6" deep concrete footing.
B. Handicapped Signs: Mount signs at height to comply with accessibility codes.

3.4 COORDINATION
A. Coordinate the installation of the identifying devices with the hardware manufacturer for lockset and knob leave outs as detailed and scheduled.

3.5 DAMAGE
A. Any identifying device which is scratched or defaced will be rejected.

3.6 CLEANING
A. Remove protective materials and clean all signs. Clean surfaces with plain water or water with soap or household detergent.

END OF SECTION
SECTION 102113
TOILET COMPARTMENTS

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. Stainless-steel toilet compartments configured as toilet enclosures and urinal screens.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions,
dimensions of individual components and profiles, and finishes.
B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to
other work.
1. Show locations of cutouts for compartment-mounted toilet accessories.
2. Show locations of reinforcements for compartment-mounted grab bars.
3. Show locations of centerlines of toilet fixtures.
4. Show overhead support or bracing locations.
C. Samples for Initial Selection: For each type of unit indicated. Include Samples of hardware and
accessories involving material and color selection.
D. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.4 QUALITY ASSURANCE
B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or
another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify
products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.
C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation
Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA)
Accessibility Guidelines for Buildings and Facilities" for toilet compartments designated as accessible.

1.5 PROJECT CONDITIONS
A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other
construction contiguous with toilet compartments by field measurements before fabrication.

1.6 WARRANTY
A. Stainless Steel Partitions - fifteen (15) years against rust-out.
B. Stainless Steel Hardware - lifetime of the partition.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
B. Stainless-Steel Castings: ASTM A 743.

2.2 STAINLESS-STEEL UNITS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Accurate Partitions Corporation.
3. Ampco, Inc.
4. Bradley Corporation; Mills Partitions.
5. Metpar Corp.
6. Sanymetal; a Crane Plumbing company.
B. Toilet-Enclosure Style: Floor anchored, overhead braced.

C. Urinal-Screen Style: Wall hung.

D. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
   1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (for doors and panels) and 1-1/4 inches for pilasters.
   2. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units.
   3. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.

E. Urinal-Screen Construction:

F. Flat-Panel Urinal Screen: Matching panel construction.

G. Facing Sheets and Closures: Stainless-steel sheet of nominal thicknesses as follows:
   1. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than 0.038 inch.
   2. Pilasters, Unbraced at One End: Manufacturer's standard thickness, but not less than 0.050 inch.
   3. Panels: Manufacturer's standard thickness, but not less than 0.031 inch.
   4. Doors: Manufacturer's standard thickness, but not less than 0.031 inch.
   5. Flat-Panel Urinal Screens: Thickness matching the panels.

H. Pilaster Shoes and Sleeves (Caps): Stainless-steel sheet, not less than 0.031-inch (nominal thickness and 3 inches (high, finished to match hardware.

I. Brackets (Fittings):
   1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

J. Stainless-Steel Finish: No. 4 bright, directional polish on exposed faces. Protect exposed surfaces from damage by application of strippable, temporary protective covering before shipment.

2.3 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   2. Hinges: Manufacturer's standard paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
   3. Latch and Keeper: Manufacturer's standard latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
   4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
   5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
   6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
   7. Connection Hardware: Continuous angle.

B. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.4 FABRICATION

A. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

B. Door Size and Swings: Unless otherwise indicated, provide 24-inch wide, in-swinging doors for standard toilet compartments and 36-inch wide, out-swinging doors with a minimum 32-inch wide, clear opening for compartments designated as accessible. Accessible doors must swing out and be self-closing.
PART 3 - EXECUTION

3.1 INSTALLATION
   A. General: Comply with manufacturer’s written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer’s recommended anchoring devices.
      1. Maximum Clearances:
         a. Pilasters and Panels: 1/2 inch.
         b. Panels and Walls: 1 inch.
   B. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches (into structural floor unless otherwise indicated in manufacturer’s written instructions). Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
   C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact. Provide blocking or metal strapping in walls for anchorage support.

3.2 ADJUSTING
   A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer’s written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION
SECTION 102220
DEMOUNTABLE PARTITIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Single source for movable glazed partitions, inclusive of frames, glass, doors, door hardware components.

1.2 REFERENCES
G. ASTM E413-87: Classification for Rating Sound Insulation.
I. Limited Production Certification (LPC), Report No. LPCE 75090-1.
J. UL 1286-2008: Office Furnishings.

1.3 PERFORMANCE REQUIREMENTS
A. Structural Performance: Provide demountable partitions capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Transverse-Load Capacity of Wall System: Lateral deflection of not more than 1/120 (solid wall) and 1/175 (glass wall) of the overall span when tested under a uniformly distributed load of 5 psf in accordance with ASTM E72 or calculated by registered engineer.
B. Sound Transmission Loss for Moveable Solid Wall: ASTM E90, STC 37.
C. Fire-Test-Response Characteristics:
   1. Surface-Burning Characteristics: Provide demountable partitions in accordance with ASTM E84, with the following maximum characteristics:
      a. Chromacoat MDF Panels: Meets Class B.
      b. Fire Rated Chromacoat MDF: Meets Class A.
      c. Pre-Finished Veneer on MDF: Meets Class C.
      d. Fabric Wrapped MDF: Meets Class C.

1.4 ADMINISTRATIVE REQUIREMENTS
A. Section 013300: Project management and coordination procedures.
B. Coordination:
   1. Coordinate other work having a direct bearing on work of this section, including other work required to be installed within or next to Work of this section.
C. Schedule:
   1. Coordinate delivery of product in accordance with construction schedule to avoid storage and double handling of the wall system.
   2. Installation of wall system in conjunction with other trades after completion of HVAC equipment, fire suppression, ceiling grid, finished drywall ceiling, floor covering, and lighting fixtures.

1.5 SUBMITTALS
A. Product Data: Provide product information for each type of product indicated in this specification.
B. Shop Drawings: Provide Shop Drawings for demountable partitions.
   1. Include plans, elevations, sections, connection details, and attachment details to other work.
   2. Include critical field measurements for standard modular installation, including finished width and height of partitions.
   3. Provide structural analysis data for installed products indicated to comply with design loads, signed and sealed by licensed professional engineer responsible for their preparation.
C. Coordination Drawings:
   1. Provide all final engineered drawings relevant to material inclusions within, or connections to the moveable wall product.
2. Provide architectural plans locating movable wall products, including wall finishes and construction of surfaces with which the moveable wall system interfaces with or connects to.
3. Provide reflected ceiling plans, drawn to scale, on which penetrations and ceiling mounted items are shown and coordinated with demountable partitions.

D. Samples: Provide samples for verification of each type of exposed finish required, in sample size indicated below.
   1. Panel Finish Face and Extrusion Components: Manufacturer's standard size unit, but not less than 3 inches square.
   2. Linear Trim: 12 inches long.
   3. Door Face Finish: Manufacturer's standard sized unit, but not less than 3 inches square.
   4. Glazing: Manufacturer's standard sized unit, but not less than 3 inches square.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of demountable partition.

F. Evaluation/Certification Reports:

G. Maintenance Data: Provide maintenance data for demountable partitions for incorporation into operation and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Sound Transmission Characteristics:
   1. Where STC ratings are indicated, provide partitions with STC rating determined by testing an identical system to ASTM E90 and classified in accordance with ASTM E413.
   2. Testing to be done by a qualified independent testing agency.

B. Mechanical Strength of Demountable Partitions: Provide demountable partitions capable of withstanding static loads in accordance with ANSI/BIFMA X5.6.

C. Mock-Up:
   1. Prior to installation of demountable partitions, build mock-up to verify selections made under sample submittals.
   2. Mock-up will demonstrate aesthetic effects and set quality standards for materials and execution.
   3. Locate where directed by Consultant.
   4. Approved mock-up may remain as part of the completed Work if undisturbed at time of Substantial Completion.

1.7 REGULATORY REQUIREMENTS
A. Conform to ADA Guidelines for accessibility requirements.

1.8 PROJECT CONDITIONS
A. Environmental Limitations: Do not deliver or install demountable partition components until building is enclosed and finishing operations are complete, including ceiling and floor-covering installation and painting.

PART 2 - PART 2 PRODUCTS

2.1 MOVABLE SOLID WALLS
A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. DIRTT Environmental Solutions; 7303 30th Street SE, Calgary, Alberta, Canada T2C 1N6. Moveable Solid Walls.
   2. Falkbuilt Ltd., Dallas North Branch; 1645 N. Stemmons Freeway, Ste A Dallas, Texas 75207.

B. Substitutions: Refer to Section 012500.

2.2 DEMOUNTABLE UNITIZED PANEL PARTITIONS (DW)
A. Glass Panels
   1. Aluminum Glazing Framing: Aluminum extrusions, 6063-T54 or 6061-T6 aluminum alloy.
         1) Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply
coating to exposed metal surfaces to comply with coating and resin manufacturers’ written instructions.

2) Color: As scheduled.

2. Glazing: Glass type indicated complying with Section 088000.

B. Frame Bases:
1. Provide frame bases with provisions for height adjustment to accommodate floor slab variances.
2. Provide a leveling mechanism for making fine adjustment in height over adjustment range of the product.

C. Connections and Supports: Manufacturer’s standard connections and supports that connect and release from floor and ceiling without damage using carpet grippers and ceiling track clips, with exception of the following conditions: bulkhead (drywall ceiling), seismic conditions, physical connections to base building (where required).

D. Panel Joint Closure: Manufacturer’s standard, capable of closing up to a 1 inch gap between demountable partitions and base building elements.

E. Trim: Continuous and modular, factory-finished, snap-on type; adjustable for variations in floor and ceiling levels.
1. Base Trim Profiles: Recessed; removable to access leveling mechanisms.
2. Ceiling Trim Profile: Recessed; adjustable to accommodate up to a 1/2 inch gap between demountable partitions and base building elements.
3. Wall Trim Profile: Recessed; adjustable to accommodate up to a 1/2 inch up to 1 inch gap between demountable partitions and base building elements.
4. Panel to Panel Profile: As detailed.
5. Colors: As scheduled.

2.3 DOORS
A. Glazed Aluminum Doors: Manufacturer’s standard stiles and rail door, sliding operation, glazed aluminum doors.
2. Door Finishes: Match partition frame.
3. Door Color: As scheduled.
5. Top Rail Height: 4 inches.
6. Bottom Rail Height: 12 inches AFF.
7. Door Height: Manufacturer’s standard. Adjustable base to move in conjunction with wall system.
8. Glazing: Manufacturer’s standard in compliance with requirements specified in Section 88000 “Glazing”.
10. Security System Components: Coordinated hardware requirements and prep work for security system components. (supplied by others).

2.4 DOOR FRAMES
A. Sliding Door Frames: Manufacturer’s standard aluminum frame single door or double door as indicated on the drawings, single continuous track mounted to demountable wall system and capable of reconfiguration without part replacement or damage to wall components.
1. Frame Finishes: Match partition frame.
2. Door Module Size: As scheduled.
4. Self-supporting header and track, jambs, sliding door, and trackless at floor between jambs.
5. Frame Height: Jambs shipped over length by 2 inches in height, for field cutting to suit opening height for proper alignment with adjacent frames.
6. Factory notched and drilled jambs for ceiling track and manufacturer’s standard header attachment.
7. Extrusion Profile: Rectilinear profile to match any adjacent unitized glass frames.
8. Frame and Track Construction:
   a. Continuous extruded frame supported or drywall header section with concealed track mechanism.
   b. Guide and alignment hardware for stabilization of door bottom.
   c. Door secured in closed position on strike side of door.
   d. Anti-rack / lift hardware included in track assembly.
9. Operation: Pneumatic slow down mechanism in door assembly mechanism to reduce travel velocity to near zero as door approaches its open and closed limit. Adjust as required after door installation.
10. Seals: Manufacturer's standard.
11. Operation and configuration ADA compliant in both clear opening and opening force in accordance with ADA Guidelines and current applicable building code.

B. Hardware: Manufacturer’s standard in compliance with requirements specified in Section 87100 “Door Hardware”.

2.5 FABRICATION

A. Demountable Unitized Panels:
1. Factory-Assembled frames with 1-inch insulation, base track and levelers; face mounted tiles installed to frames on site.
2. Fabricate panels for installation with concealed fastening devices and pressure-fit components that will not damage ceiling or floor covering exceptions.
3. Fabricate panels with continuous light-and-sound seals at floor, ceiling, and other locations where panels abut fixed construction.
4. Factory glaze panels to the greatest extent possible.

B. Components:
1. Fabricate components for installation with concealed fastening devices and pressure-fit members that will not damage ceiling or floor coverings. Exceptions: Drywall ceiling, seismic applications and doors against base building require screw holes in base building for proper fastening.
2. Fabricate for installation with continuous seals at floor and other locations where partition assemblies abut fixed construction and for installation of sound attenuation insulation in partition cavities.

2.6 FINISHES

A. Protect finishes on exposed surfaces from damage during shipping.
B. Appearance of Finished Work:
1. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved samples.
2. Noticeable variations in the same piece are not acceptable.
3. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install demountable partition systems to manufacturer's written instructions.
B. Install system rigid, level, plumb, and aligned.
C. Apply finished face mounted tiles to framing.
D. Install continuous insulation in base trim cavity.
E. Install seals to prevent light and sound transmission at connections to floors, ceilings, fixed walls, and abutting surfaces.
F. Install doors and frames, glazing, and glazing frame assemblies securely anchored to partitions and with doors aligned and fitted.
G. Install and adjust door hardware for proper operation.
H. Align mullions with exterior window mullions.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to demonstrate and train Owner's maintenance personnel to adjust, operate, and maintain demountable partitions.

END OF SECTION
SECTION 102600
WALL AND DOOR PROTECTION

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Corner guards.

1.3 SUBMITTALS
A. Product Data: Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each impact-resistant wall protection unit.
B. Material Certificates: For each impact-resistant plastic material, from manufacturer.
C. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
B. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.
C. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated. Refer to Division 01 Section "Quality Requirements."
   1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
   2. Surface-Burning Characteristics: Provide impact-resistant, plastic wall protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another qualified testing agency.
D. Regulatory Requirements:
   1. Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

1.5 PROJECT CONDITIONS
A. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F for not less than 72 hours before beginning installation and for the remainder of the construction period.

1.6 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
   2. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
B. Include mounting and accessory components. Replacement materials shall be from same production run as installed units.
PART 2 - PRODUCTS

2.1 MATERIALS
   A. Stainless-Steel Sheet: ASTM A 240.
   B. Fasteners: Aluminum, nonmagnetic stainless-steel, or other non-corrosive metal screws, bolts, and other
      fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
   C. Adhesive: As recommended by impact-resistant plastic wall protection manufacturer and with a VOC
      content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 CORNER GUARDS (CG)
   A. Surface-Mounted, Metal Corner Guards: Fabricated from one-piece, formed or extruded metal with
      formed edges; with 90- or 135-degree turn to match wall condition.
      1. Manufacturers: Subject to compliance with requirements, provide products by Korogard Wall
         Protection Systems; a division of RJF International Corporation or a comparable product by one of
         the following:
            a. Balco, Inc.
            b. Construction Specialties, Inc.
            c. IPC Door and Wall Protection Systems; Division of InPro Corporation.
            d. Pawling Corporation.
         a. Thickness: Minimum 0.0625 inch.
         b. Color: As scheduled.
      3. Wing Size: 1-1/2 inches.
      5. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes.
      6. Height: 48 inches U.O.N.

2.3 FABRICATION
   A. Fabricate impact-resistant wall protection units to comply with requirements indicated for design,
      dimensions, and member sizes, including thicknesses of components.
   B. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only
      as necessary for shipping and handling.
   C. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of
      wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to
      produce flush, smooth, and rigid hairline joints.

2.4 METAL FINISHES
   A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations
      for applying and designating finishes.
      1. Remove tool and die marks and stretch lines, or blend into finish.
      2. Grind and polish surfaces to produce uniform finish, free of cross scratches.
      3. Run grain of directional finishes with long dimension of each piece.
      4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and
         leave surfaces chemically clean.
   B. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering
      before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation
      tolerances and other conditions affecting performance of work.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Complete finishing operations, including painting, before installing impact-resistant wall protection system
      components.
   B. Before installation, clean substrate to remove dust, debris, and loose particles.
3.3 INSTALLATION
   A. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
      1. Provide, mounting hardware, anchors, and other accessories required for a complete installation.
         a. Provide anchoring devices to withstand imposed loads.

3.4 CLEANING
   A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.
   B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION
SECTION 102800
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Public-use washroom accessories.
      2. Childcare accessories.
      3. Underlavatory guards.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated. Include the following:
      1. Construction details and dimensions.
      2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
      3. Material and finish descriptions.
      4. Features that will be included for Project.
      5. Manufacturer's warranty.
   B. Product Schedule: Indicating types, sizes, and installation locations by room of each accessory required.
      1. Identify locations using room designations indicated.
      2. Identify products using designations indicated.

1.4 QUALITY ASSURANCE
   A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

1.5 COORDINATION
   A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
   B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.6 WARRANTY
   A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
      1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
   B. Brass: ASTM B 19, flat products; ASTM B 16, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
   C. Steel Sheet: ASTM A 1008, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.
   D. Galvanized-Steel Sheet: ASTM A 653, with G60 hot-dip zinc coating.
   F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
   G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
   H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Specialties, Inc.
   2. Bobrick Washroom Equipment, Inc.
   4. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.

B. Mirror Unit (B):
   2. Frame: Stainless-steel channel.
      a. Corners: Manufacturer's standard.
      a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
      b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.

C. Grab Bar (C1), (C2):
   1. Basis-of-Design Product: B-5806 x 36 and B-5806 x 42 by Bobrick Washroom Equipment, Inc.
   3. Material: Stainless steel, 0.05 inch thick.
      a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.

D. Toilet Tissue (Roll) Dispenser (D):
   2. Description: Double-roll dispenser.
   5. Capacity: Designed for 5-inch- diameter tissue rolls.

E. Combination Towel (Folded) Dispenser/Waste Receptacle (E):
   2. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
      a. Designed for nominal 4-inch wall depth.
   4. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multifold paper towels.
   7. Liner: Reusable, vinyl waste-receptacle liner.
   8. Lockset: Tumbler type for towel-dispenser compartment and waste receptacle.

F. Garment Hook (F1)-HC, (F2):
   2. Description: Heavy duty clothes hook.

G. Liquid-Soap Dispenser: (J):
   2. Description: Designed for dispensing soap in liquid or lotion form.
   3. Mounting: Lavatory (Deck) mounted.

H. Sanitary-Napkin Disposal Unit (K):
   3. Door or Cover: Self-closing, disposal-opening cover and hinged face panel with tumbler lockset.
   5. Material and Finish: Stainless steel, No. 4 finish (satin).

I. Seat-Cover Dispenser (L):
   5. Lockset: Manufacturer's standard.
J. Liquid-Soap Dispenser (M):
2. Description: Designed for dispensing soap in liquid or lotion form.

2.3 CHILDCARE ACCESSORIES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Specialties, Inc.
2. Brocar Products, Inc.
3. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
4. Koala Kare Products; a division of Bobrick Washroom Equipment, Inc.
5. Tubular Specialties Manufacturing, Inc.
B. Diaper-Changing Station (I):
1. Basis-of-Design Product: KB110-SSWM, by Koala Kare Products; a division of Bobrick Washroom Equipment, Inc.
2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
   a. Engineered to support a minimum of 250-lb static load when opened.
3. Mounting: Surface mounted, with unit projecting not more than 4 inches from wall when closed.
5. Material and Finish: Stainless steel, No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners.

2.4 UNDERLAVATORY GUARDS
A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Plumberex Specialty Products, Inc.
2. Truebro by IPS Corporation.
B. Color: White.

2.5 FABRICATION
A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
B. Keys: Provide universal keys for internal access to accessories for servicing and re-supplying. Provide minimum of six keys to Owner’s representative.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
B. Grab Bars and Baby Changing Stations: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING
A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
B. Remove temporary labels and protective coatings.
C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION
SECTION 104413

FIRE PROTECTION CABINETS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Fire protection cabinets for the following:
      a. Portable fire extinguishers.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
   1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
   2. Show location of knockouts for hose valves.
B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
   1. Size: 6 by 6 inches square.

1.4 QUALITY ASSURANCE
A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 COORDINATION
A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.
C. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.6 SEQUENCING
A. Apply vinyl lettering on field-painted, fire protection cabinets after painting is complete.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
B. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
C. Stainless-Steel Sheet: ASTM A 666, Type 304.
D. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).
2.2 FIRE EXTINGUISHER CABINET (J)

A. Cabinet Type: Suitable for fire extinguisher.
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
   b. Larsen's Manufacturing Company.
   c. Potter Roemer LLC.

B. Cabinet Construction: Non-rated in non-rated walls; 1-or-2-hour fire rated in rated walls to match rating of wall.
1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch-thick, cold-rolled steel sheet lined with minimum 5/8-inch-thick, fire-barrier material. Provide factory-drilled mounting holes.

C. Materials:
1. Aluminum: ASTM B 221 (ASTM B 221M) for extruded shapes and aluminum sheet, with strength and durability characteristics of not less than Alloy 6063-T5 for aluminum sheet.
   a. Finish: Clear anodic.

D. Semi-recessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semi-recessed cabinet installation.
   1. Rolled-Edge Trim: 2-1/2-inch backbend depth.

E. Cabinet Trim Material: Aluminum sheet.
F. Door Material: Aluminum sheet.
G. Door Style: Vertical duo panel with frame.
H. Door Glazing: Tempered float glass (clear).
I. Door Hardware: Manufacturer’s standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
   1. Provide projecting lever handle with cam-action latch.
   2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
J. Accessories:
   1. Mounting Bracket: Manufacturer’s standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with satin anodized finish.
   2. Shelf: Same metal and finish as cabinet.
K. Finishes:
   1. Exterior of cabinet, door, and trim:
      a. Satin anodized.
   2. Interior of cabinet and door: Match exterior.

2.3 FABRICATION

A. Fire Protection Cabinets: Provide manufacturer’s standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.
   2. Provide factory-drilled mounting holes.
   3. Prepare doors and frames to receive locks.
   4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer’s standards, from materials indicated and coordinated with cabinet types and trim styles selected.
   1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
   2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for cabinets to verify actual locations of piping connections before cabinet installation.
B. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION
A. Prepare recesses for semi-recessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION
A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
   1. Fire Protection Cabinets: Refer to drawing A5.02.
B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
   1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semi-recessed fire protection cabinets.
   2. Provide inside latch and lock for break-glass panels.
   3. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.
   4. Fire-Rated Cabinets:
      a. Install cabinet with not more than 1/16-inch tolerance between pipe OD and knockout OD. Center pipe within knockout.
      b. Seal through penetrations with firestopping sealant as specified in Division 07 Section "Penetration Firestopping."
C. Identification: Apply vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING
A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION
SECTION 104416
FIRE EXTINGUISHERS

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 portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
B. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE
A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.5 COORDINATION
A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.6 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
   2. Failure of hydrostatic test according to NFPA 10.
      a. Faulty operation of valves or release levers.
   3. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS (Drawing Designation FE)
A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Larsen's Manufacturing Company.
      c. Potter Roemer LLC.
   2. Valves: Manufacturer's standard.
   3. Handles and Levers: Manufacturer's standard.
   4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.
B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
C. Wet-Chemical Type in Steel Container (at Break room areas): UL-rated 2-A:K, 2.5-lb nominal capacity, with potassium acetate-based chemical in stainless steel container; with pressure indicating gauge.
2.2 MOUNTING BRACKETS
A. Location: For all extinguishers not placed in fire extinguisher cabinet, provide mounting bracket.
B. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Larsen's Manufacturing Company.
      c. Potter Roemer LLC.
C. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.
   B. Shop Drawings: For metal lockers. Include plans, elevations, sections, details, and attachments to other work.
      1. Show locker trim and accessories.
      2. Include locker identification system and numbering sequence.
   C. Samples for Initial Selection: For units with factory-applied color finishes.
   D. Samples for Verification: For metal lockers and locker benches, in manufacturer's standard sizes.
   E. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE
   A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   B. Source Limitations: Obtain metal lockers and accessories from single source from single manufacturer.
   C. Regulatory Requirements: Where metal lockers are indicated to comply with accessibility requirements, comply with:

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

1.6 PROJECT CONDITIONS
   A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.7 COORDINATION
   A. Coordinate sizes and locations of bases for metal lockers.
   B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.8 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Structural failures.
         b. Faulty operation of latches and other door hardware.
      2. Damage from deliberate destruction and vandalism is excluded.
      3. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.
1.9 EXTRA MATERIALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Full-size units of the following metal locker hardware items equal to 10 percent of amount installed for each type and finish installed, but no fewer than five units:
         a. Lock mechanism.
         b. Identification plates.
         c. Hooks.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B, suitable for exposed applications.
   B. Stainless-Steel Sheet: ASTM A 666, Type 304.
   C. Steel Tube: ASTM A 500, cold rolled.
   D. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
   E. Anchors: Material, type, and size required for secure anchorage to each substrate.
      1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls, and elsewhere as indicated, for corrosion resistance.
      2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.2 METAL LOCKERS (L)
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      2. List Industries Inc.
      3. Lyon Workspace Products, LLC
      4. Penco Products, Inc.
   B. Type: Two-tier as indicated on the Drawings.
   C. Material: Cold-rolled steel sheet.
   D. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet as follows:
      1. Tops, Bottoms, and Intermediate Dividers: 0.024-inch nominal thickness, with single bend at sides.
      2. Backs and Sides: 0.024-inch nominal thickness, with full-height, double-flanged connections.
      3. Shelves: 0.024-inch nominal thickness, with double bend at front and single bend at sides and back.
   E. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.
      1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
      2. Frame Vents: Fabricate face frames with vents.
   F. Doors: One piece; fabricated from 0.060-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
      1. Doors less than 12 inches wide may be fabricated from 0.048-inch nominal-thickness steel sheet.
      2. Doors for box lockers less than 15 inches wide may be fabricated from 0.048-inch nominal-thickness steel sheet.
      3. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
      4. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch nominal-thickness steel sheet; welded to inner face of doors.
      5. Sound-Dampening Panels: Manufacturer's standard, designed to stiffen doors and reduce sound levels when doors are closed, of die-formed metal with full perimeter flange and sound-dampening material; welded to inner face of doors.
      6. Door Style: Unperforated panel. Vented panel as follows:
         a. Concealed Vents: Slotted perforations in top and bottom horizontal return flanges of doors.
   G. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
      1. Continuous Hinges: Manufacturer's standard, steel, full height.
   H. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device
does not protrude beyond face of door; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and prelocking.
   a. Latch Hooks: Equip doors 48 inches and higher with three-latch hooks and doors less than 48 inches high with two-latch hooks; fabricated from 0.105-inch nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
   b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated with vinyl or nylon to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

I. Combination Padlocks: Provided by user.

J. Equipment: Equip each metal locker with identification plate and the following unless otherwise indicated:
   1. Coat Rods: In lieu of ceiling hook for metal lockers 24 inches high or more and 18 inches or deeper.
   2. Coat Hooks: Provide as standard with manufacturer, but not less than one multi-prong at top of 1/2 and 1/3 height lockers.

K. Accessories:
      a. Height: 4 inches.
   2. Recess Trim: Fabricated from 0.048-inch nominal-thickness steel sheet.
   3. Filler Panels: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch nominal-thickness steel sheet.
   4. Boxed End Panels: Fabricated from 0.060-inch nominal-thickness steel sheet.
   5. Finished End Panels: Fabricated from 0.024-inch nominal-thickness steel sheet.

L. Finish: Baked enamel.
   1. Color(s): Custom, as scheduled, refer to drawing A5.01.

2.3 FABRICATION

A. Fabricate metal lockers square, rigid, and without warp and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
   1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
   2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.

C. Knocked-Down Construction: Fabricate metal lockers using nuts, bolts, screws, or rivets for nominal assembly at Project site.

D. Accessible Lockers: Fabricate as follows:
   1. Locate bottom shelf no lower than 15 inches above the floor.
   2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.

E. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.

F. Coat Rods: Fabricated from 3/4-inch-diameter steel, chrome finished.

G. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 1/2 inch high. Sequence numbers as directed by Architect. Attach plates on center of door near top.

H. Continuous Base: Formed into channel or zee profile for stiffness, and fabricated in lengths as long as practical to enclose base and base ends of metal lockers; finished to match lockers.

I. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
   1. Sloping-top corner fillers, mitered.

J. Recess Trim: Fabricated with minimum 2-1/2-inch face width and in lengths as long as practical; finished to match lockers.

K. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

L. Boxed End Panels: Fabricated with 1-inch-wide edge dimension, and designed for concealing fasteners and holes at exposed ends of non-recessed metal lockers; finished to match lockers.
   1. Provide one-piece panels for double-row (back-to-back) locker ends.

M. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of non-recessed metal lockers; finished to match lockers.
   1. Provide one-piece panels for double-row (back-to-back) locker ends.
2.4 STEEL SHEET FINISHES
A. Factory finish steel surfaces and accessories except stainless-steel and chrome-plated surfaces.
B. Baked-Enamel Finish: Immediately after cleaning, pretreating, and phosphatizing, apply manufacturer’s standard thermosetting baked-enamel finish. Comply with paint manufacturer’s written instructions for application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. General: Install level, plumb, and true; shim as required, using concealed shims.
   1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
   2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
   3. Anchor back-to-back metal lockers to floor.
B. Knocked-Down Metal Lockers: Assemble with standard fasteners, with no exposed fasteners on door faces or face frames.
C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
   1. Attach hooks with at least two fasteners.
   2. Attach door locks on doors using security-type fasteners.
   3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
      a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
   4. Attach recess trim to recessed metal lockers with concealed clips.
   5. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
   6. Attach sloping-top units to metal lockers, with closures at exposed ends.
   7. Attach boxed end panels with concealed fasteners to conceal exposed ends of non-recessed metal lockers.
   8. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of non-recessed metal lockers.

3.3 ADJUSTING, CLEANING, AND PROTECTION
A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.
B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION
SECTION 108113
BIRD CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes: Bird Control Devices:
   1. Needle Strips.

1.2 SYSTEM DESCRIPTION
A. Design Requirements: Select appropriate sizes, shapes, and fastening system as determined by site conditions.

1.3 SUBMITTALS
A. General: Submit in accordance with Section 013300.
B. Product Data: Submit manufacturer’s descriptive literature and product specifications for each product.
C. Shop Drawings: Indicate typical layout in plan and elevation including dimensions and anchoring provisions.
   1. Submit detail drawings of special accessory components not included in manufacturer’s product data.
D. Samples: Submit samples of each type device, including proposed fastening methods and hardware.
E. Informational Submittals: Submit following packaged separately from other submittals:
   1. Qualification Data: Installer’s qualifications verifying years of experience.
      a. Include list of completed projects having similar scope of Work identified by name, location, date, reference names, and phone numbers.
   2. Manufacturer’s printed installation instructions.
      a. Indicate by transmittal that copies of instructions and recommendations have been distributed to installer.
F. Warranty: Submit specified warranty in accordance with Section 017839.

1.4 QUALITY ASSURANCE
A. Single Source Responsibility: Furnish products from one manufacturer for entire Project, unless otherwise acceptable to Architect.
B. Installer Qualifications: Documented experience on at least 5 projects of similar nature in past 5 years.

1.5 FIELD SAMPLES
A. Sample Installation:
   1. Install 12 lineal feet of samples on actual construction for approval.
   2. Locate on project elements where directed by Architect.
   3. Mock-up will be reviewed for installation, appearance, connections, profiles, and dimensions.
   4. Accepted Field Sample: May remain part of completed Work.

1.6 DELIVERY, STORAGE AND HANDLING
A. Deliver materials to job site with manufacturer’s labels intact and legible, in original packages or containers. Materials shall be kept dry during storage period.
B. Use means as necessary to protect compartments and screens before, during and after installation. In event of damage, immediately make necessary repairs and replacements.

1.7 WARRANTY
A. Special Warranty: Prepare and submit in accordance with Section 017839.
   1. Warrant installed system to be free from defects in material and workmanship for two years.
   2. Include provisions stating that building areas adjacent to entrances, recesses, and walkways will be free from bird pest problems and that adjustment or additional material as may be required shall be installed to maintain pest free condition at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 NEEDLE STRIP BIRD CONTROL MATERIALS
A. Needle Strip Bird Control - (90 degree): UNS S30200 stainless steel.
   1. Width: 3 inches.
2. Height: 4 inches.
5. Lengths: Manufacturer’s standards.
6. Shape, Mounting System, and Number of Rows: As determined by manufacturer based on Project conditions.
   a. Substitutions: In accordance with section 012500 “Substitution Procedures”.

B. Needle Strip Bird Control - (180 degree): UNS S30200 stainless steel.
1. Width: 6 inches.
2. Height: 4 inches.
5. Lengths: Manufacturer’s standards.
6. Shape, Mounting System, and Number of Rows: As determined by manufacturer based on Project conditions.

C. Accessories:
1. All permanent fittings shall be non-corrosive. All fastenings and hardware shall be stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine conditions and proceed with work in accordance with Section 017300.

3.2 PREPARATION
A. Substrate: Clean and dry at time of installation.
   1. Remove bird debris and thoroughly clean surfaces.

3.3 NEEDLE STRIP BIRD CONTROL INSTALLATION
A. General: Install in accordance with Section 017300.
   1. Use concealed fasteners when possible.
   2. Attachments shall not have detrimental affect on watertight integrity of building components.
B. Needle Strip Bird Control: Install materials neatly, tangent to surface, straight and uniform in appearance, and with no end gaps.
   1. Cover entire depth of protrusions, ledges, and other potential roosting surfaces, not just perimeter.
   2. Follow contours and angles closely; cut to fit properly.
   3. Space materials in accordance with manufacturer’s recommendations.
   4. Provide removable sections to allow building and window maintenance and cleaning at areas indicated.

3.4 ADJUSTING
A. Adjust materials to ensure birds cannot roost within protected areas.

END OF SECTION
SECTION 109900
MISCELLANEOUS SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY
A. Related Sections: Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
B. Section Includes:
   1. Miscellaneous specialty items as listed herein.

1.2 SUBMITTALS
A. General: Submit following items in accordance with Section 013300.
B. Product Data: Including all pertinent performance characteristics and criteria.
C. Shop Drawings: Indicate materials, construction, sizes, quantities, finishes, and installation details.
D. Manufacturer's Instructions: For installation, maintenance, and repair.

1.3 DELIVERY, STORAGE AND HANDLING
A. Deliver, store, handle, and protect products in accordance with Section 016000.

PART 2 - PRODUCTS

2.1 PRODUCTS
A. Fire Control Key Box: Provide recessed fire department key control box, equal to model 3200 by Knox Box, one at building entrance.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify that surfaces and conditions are ready to receive work of this Section.
B. Notify Architect of any existing conditions which will adversely affect execution.
C. Beginning of execution will constitute acceptance of existing conditions.

3.2 PREPARATION
A. Prepare substrate surfaces as recommended by manufacturer.

3.3 INSTALLATION
A. Install using skilled workmen in accordance with manufacturer's printed instructions and recommendations.
B. Coordinate interface with ductwork for kiln installation.

3.4 ADJUSTING
A. Adjust and fit items to be flush with adjacent construction.
B. Fasten or adhere for tight connections and joints.

3.5 CLEANING
A. Perform final cleaning in accordance with Section 017400.

3.6 PROTECTION
A. Protect finished installation in accordance with Section 015000.

END OF SECTION
SECTION 113100

RESIDENTIAL APPLIANCES

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: Residential appliances as indicated on the Drawings.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, dimensions, furnished accessories, and finishes for each appliance.
B. Product Schedule: For appliances. Use same designations indicated on Drawings.
C. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE
A. Manufacturer Qualifications: Maintains, within 25 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
B. Installer Qualifications: An employer of workers trained and approved by manufacturer for installation and maintenance of units required for this Project.
C. Source Limitations: Obtain each type of residential appliance from single manufacturer.
D. Regulatory Requirements: Comply with the following:
   1. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 WARRANTY
A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period except as qualified below:
   1. Warranty Period: Two years from date of Substantial Completion.
B. Refrigerator/Freezer Icemaker, Sealed System: Full warranty including parts and labor for on-site service on the product.
   1. Warranty Period for Sealed Refrigeration System: Five years from date of Substantial Completion.
   2. Warranty Period for Other Components: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 REFRIGERATOR/FREEZERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Samsung
B. Refrigerator/Freezer: Complying with AHAM HRF-1.
   2. Type: Freestanding, Side-by-Side.
   3. General Features:
      a. Dispenser in door for ice and cold water.
      b. Built-in water filtration system.
      c. Factory installed ice-maker.
      d. Separate touch-pad temperature controls for each compartment.
   4. Refrigerator Features:
      a. Interior light in refrigeration compartment.
      b. Compartment Storage: Vegetable crisper, meat compartment.
      c. Door Storage: Modular compartments.
      d. Temperature-controlled meat/deli bin.
5. Freezer Features: One freezer compartment(s).
   a. Automatic defrost.
   b. Interior light in freezer compartment.


7. Front Panel(s): Manufacturer’s standard.


C. Waste Disposer:
   3. Wall switch operator.

2.2 GENERAL FINISH REQUIREMENTS
   A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
   B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.
   C. Examine walls, ceilings, and roofs for suitable conditions where overhead exhaust hoods and microwave ovens with vented exhaust fans will be installed.
   D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
   E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL
   A. General: Comply with manufacturer's written instructions.
   B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.
   C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
   D. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions.
   E. Utilities: See Divisions 22 and 26 for plumbing and electrical requirements.

END OF SECTION 113100
SECTION 115117

LIBRARY BOOK DROP AND RETURN

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes: Providing miscellaneous library equipment as specified herein.
B. Related sections include the following:
   1. Joint Sealant Section 079200.

1.2 ACTION SUBMITTALS
A. Submit the following in accordance with Section 013300.
B. Product Data: Submit product data for each type of library equipment item.
C. Shop Drawings: Indicate construction materials, finishes, sizes, quantities, and related hardware requirements.

1.3 SEQUENCING, SCHEDULING, AND COORDINATION
A. Consult with other trades in advance and make provisions for their work to avoid cutting and patching.
B. Notify responsible trades of schedules so as to allow adequate time for installation and coordination of their work.
C. Furnish inserts and anchoring devices which must be built into other work for installation of book return sleeves. Coordinate delivery with other work to avoid delay.

PART 2 - PRODUCTS

2.1 BOOK RETURN
A. Basis-of-Design Manufacturer: Kingsley Library Equipment Company, Pomona, CA.
B. Substitutions: Under provisions of Section 012500.
C. Components and Attributes: Provide with the following:
   1. Model #0012 heavy duty stainless steel fire-deterrent chute.
   2. Manufacturer’s standard metal weather hood.
   3. Model #0120 stainless steel faceplate with standard wording “BOOK RETURN” silk-screened onto face; provide with locking mechanism accessible from interior only. Provide faceplate sleeve in depth necessary to accommodate scheduled exterior wall construction and thickness.
   4. Faceplate sign to direct users to return items inside when book return is locked.

2.2 BOOK DROP
A. Basis-of-Design Manufacturer: Salisbury Industries, Los Angeles, CA, (800) 725-7287.
B. Substitutions: Under provisions of Section 012500.
C. Components and Attributes: Provide with the following:
   1. Model No. 2265, 20 gage steel through-wall sleeve, with 1/4-inch aluminum wall plate with spring-loaded door flap.
   2. Size: 14 inches wide, 7 inches H, 6 1/4 inches D; door opening - 11 x 4 inches.
   3. Custom engrave with the following text: BOOK DROP

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify that surfaces and conditions are ready to receive work of this Section.
B. Verify rough openings are correctly located, sized and prepared for installation.
C. Correct existing conditions which will adversely affect installation.

3.2 PREPARATION
A. Prepare substrate surfaces as recommended by book return manufacturer.
3.3 INSTALLATION:
A. Install book returns using skilled workers in accordance with manufacturer’s printed instructions and recommendations.
B. Use fasteners which are appropriate to substrate and recommended by manufacturer of unit.
C. Install units plumb and level, firmly anchored in locations and at heights indicated.
D. Seal perimeter with joint sealant specified in Section 079200.

3.4 ADJUSTING AND CLEANING:
A. Adjust and fit items to be flush with adjacent construction, where applicable.
B. Adjust units for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.
C. Clean and polish all exposed surfaces after removing protective coatings.
D. Clean up all debris caused by the work of this Section, keeping the premises clean and neat at all times.

END OF SECTION
SECTION 115213
PROJECTION SCREENS

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. Recessed, electrically operated projection screens and controls.

1.3 DEFINITIONS
A. Gain of Front-Projection Screens: Ratio of light reflected from screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94.
B. Half-Gain Angle: The angle, measured from the axis of the screen surface to the most central position on a perpendicular plane through the horizontal centerline of the screen where the gain is half of the peak gain.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: For projection screens. Show layouts and types of projection screens. Include the following:
   1. For manually operated projection screens:
      a. Anchorage details.
      b. Accessories.
C. Maintenance Data: For projection screens to include in maintenance manuals.

1.5 QUALITY ASSURANCE
A. Source Limitations for Projection Screens: Obtain each type of projection screen from single manufacturer. Obtain accessories, including necessary mounting hardware, from screen manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Environmental Limitations: Do not deliver or install projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 COORDINATION
A. Coordinate layout and installation of projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC equipment, fire-suppression system, and partitions.

PART 2 - PRODUCTS

2.1 ELECTRICALLY OPERATED PROJECTION SCREENS
A. General: Manufacturer’s standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Controls: Remote, three-position control switch installed in recessed device box with flush cover plate matching other electrical device cover plates in room where switch is installed.
      a. Provide two control switches for each screen.
      b. Provide power supply for low-voltage systems if required.
      c. Provide locking cover plates for switches.
      d. Provide key-operated, power-supply switch.
   2. Motor in Roller: Instant-reversing motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection,
preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.

3. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a 3/8-inch-diameter metal rod with ends of rod protected by plastic caps.
   a. Roller for motor in roller supported by vibration- and noise-absorbing supports.

4. Tab Tensioning: Provide units that have a durable low-stretch cord, such as braided polyester, on each side of screen connected to edge of screen by tabs to pull screen flat horizontally.

B. Suspended, Electrically Operated Screens with Automatic Ceiling Closure: Motor-in-roller units designed and fabricated for suspended mounting; with bottom of case composed of two panels, fully enclosing screen, motor, and wiring; one panel hinged and designed to open and close automatically when screen is lowered and fully raised, the other removable or openable for access to interior of case.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Motor in Roller:
         1) Da-Lite Screen Company; Boardroom Electrol.
         2) Draper Inc.; Envoy.
         3) Stewart Filmscreen Corporation; Model ABT-4.
   2. Provide metal or metal-lined motor enclosure on units with end-mounted motor.
   3. Provide metal or metal-lined wiring compartment on units with motor in roller.
   4. Screen Case: Made from metal.
   5. Provide screen case with trim flange to receive ceiling finish.

2.2 FRONT-PROJECTION SCREEN MATERIAL
   A. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
   B. Seams: Where length of screen indicated exceeds maximum length produced without seams in material specified, provide screen with horizontal seam placed as follows:
      1. At bottom of screen at juncture between extra drop length and viewing surface.
      2. In location indicated.
   C. Size of Viewing Surface: Refer to Drawings.

PART 3 - EXECUTION

3.1 FRONT-PROJECTION SCREEN INSTALLATION
   A. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions.
   B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
      1. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.
         a. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
      2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
      3. Test manually operated units to verify that screen-operating components are in optimum functioning condition.

END OF SECTION
SECTION 115224

FLAT SCREEN TV MOUNTS

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 flat screen TV hanger assembly.

1.3 ACTION SUBMITTALS
A. Product Data: Submit product data for Flat Screen TV Hanger Assembly.
B. Shop Drawings: Submit shop drawings for Flat Screen TV Hanger Assembly.
C. Show location and details including support assembly and television mount.

1.4 INFORMATIONAL SUBMITTALS
A. Informational Submittals: Submit following:
   1. Certifications specified in Quality Assurance article.
   2. Qualification Data: Manufacturer’s qualification data.
   3. Manufacturer’s instructions.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum five years documented experience.
B. Certifications: Submit manufacturer’s certification that products furnished for Project meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Acceptable Manufacturers:
   1. Bretford Manufacturing, Inc.
   2. Draper, Inc.
   3. Lucasey.
   4. Peerless Industries, Inc.
B. Acceptable Product (for “Proposed TV Size”):
   1. SMS WH3D Wall Mount as manufactured by Draper.

2.2 FLAT SCREEN TV HANGER ASSEMBLY
A. Proposed TV Size: 70-90 inches.
B. Components:
   1. Support column: Extruded aluminum tubular section with matt black powder coat finish and top and bottom steel plates for wall attachment.
      a. Provide channel on side of column for cable management. Video cables to be retained in channel with clips.
   2. Tilt mechanism: Steel rectangular frame attached to column and equipped with mating bracket to accept keystone plate of plasma monitor bracket. Plasma display may be installed horizontally or vertically.
   3. Finish: Matte black powder coat.
   4. Adjustment capability:
      a. Tilt: 15 degrees.
      b. Rotation: 20 degrees.
5. Load Capacity: As required to safely support screen.
6. Wall-mounting Bracket: Provide assembly consisting of cover plate, mounting plate, and wall framing reinforcement brackets.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine conditions under which work of this Section is to be installed. Do not proceed until unsatisfactory conditions have been corrected.
B. Verify wood blocking has been integrated into wall construction to accept secure attachment of flat screen TV hanger assemblies. Do not attach to assemblies to gypsum board.

3.2 INSTALLATION
A. Flat Screen TV Hanger Assembly: Install in accordance with Section 017000 and approved shop drawings.
   1. Install units plumb, level, square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction.
B. Use fasteners which are appropriate to substrate and recommended by manufacturer of unit.
C. Install units firmly anchored in locations and at heights indicated.

3.3 ADJUSTING
A. Adjust parts for smooth, uniform operation.

3.4 CLEANING AND PROTECTION
A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish or surrounding construction.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes manual roller shades and motorized shade operators.
B. Related Sections include the following:
   1. Division 26 Sections for electrical service and connections for motor operators, controls, limit switches, and other powered devices and for system disconnect switches for motorized shade operation.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
   1. Motorized Shade Operators: Include operating instructions.
   2. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
B. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.
   1. Motorized Shade Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
   2. Wiring Diagrams: Power, system, and control wiring.
C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Ceiling suspension system members and attachment to building structure.
   2. Ceiling-mounted or penetrating items including light fixtures, air outlets and inlets, speakers, sprinklers, recessed shades, and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.
   3. Shade mounting assembly and attachment.
   4. Size and location of access to shade operator, motor, and adjustable components.
   5. Minimum Drawing Scale: 1/4 inch = 1 foot.
D. Samples for Initial Selection: For each colored component of each type of shade indicated.
   1. Include similar Samples of accessories involving color selection.
E. Samples for Verification:
   1. Complete, full-size operating unit not less than 16 inches wide for each type of roller shade indicated.
   2. For the following products:
      a. Shade Material: Not less than 12-inch- square section of fabric, from dye lot used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of material.
F. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
   1. Methods for maintaining roller shades and finishes.
   2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
   3. Operating hardware.
   4. Motorized shade operator.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: Fabricator of products.
B. Source Limitations: Obtain roller shades through one source from a single manufacturer.
C. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Product Standard: Provide roller shades complying with WCMA A 100.1.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory packages, marked with manufacturer and product name, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 ROLLER SHADES (SH)

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Lutron Shading Solutions by VIMCO.
3. MechoShade Systems, Inc.

B. Basis-of-Design Product: As scheduled.

C. Shade Band Material: PVC-coated fiberglass and polyester blends.

1. Pattern, Style, Color, open-ness: As scheduled.

D. Rollers: Electro-galvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with manufacturer's standard method for attaching shade material. Provide capacity for two roller shade band(s) per roller, unless otherwise indicated on Drawings.

E. Direction of Roll: Regular, from back of roller.

F. Mounting Brackets: Fascia end caps, fabricated from steel finished to match fascia or headbox.

G. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated; removable design for access.

H. Top/Back Cover: L-shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.

I. Pocket with Ceiling Slot Opening: Six-sided box units for recessed installation; fabricated from formed-steel sheet, extruded aluminum, or wood; with a bottom consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing rollers, brackets, and operating hardware and operators within; capacity for two roller shades overlapping in queued pattern, front and back per pocket, unless otherwise indicated.

1. Corner Section: Factory formed and welded.

J. Bottom Bar: Steel or extruded aluminum, with plastic or metal capped ends. Provide-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

K. Mounting: Inside Recessed in ceiling pocket mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

L. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard for fixing shade in place, keeping shade band material taut, and reducing light gaps when shades are closed.

M. Shade Operation: Manual; with continuous-loop bead-chain, clutch, and cord tensioner and bracket lift operator.
1. Pull: Manufacturer's standard hand-grip engaged pull.
2. Clutch: Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
3. Lift-Assist Mechanism: Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.
4. Loop Length: Length required to make operation convenient from floor level.
5. Bead Chain: Nickel-plated metal or stainless steel.


2.2 ROLLER SHADE FABRICATION
A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.
B. Concealed Components: Non-corrodible or corrosion-resistant-coated materials.
 1. Lifting Mechanism: With permanently lubricated moving parts.
C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:
  1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
  2. Shade Units Installed Outside Jambs: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting fascia, headbox, roller, and operating hardware and for hardware position and shade mounting method indicated.
E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal non-corrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.
F. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
G. Colors of Metal and Plastic Components Exposed to View: As indicated by manufacturer's designations, unless otherwise indicated.

2.3 MOTORIZED ROLLER SHADE OPERATORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Manufacturer of roller shade.
B. General: Provide factory-assembled motorized shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by shade manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.
C. Comply with NFPA 70.
D. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
E. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection, brake, permanently lubricated bearings, and limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.
  1. Service Factor: According to NEMA MG 1, unless otherwise indicated.
F. Position of Motor and Electrical Connection: Left side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated on Drawings.
G. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following devices for remote-control activation of shades:
  1. Control Stations: Keyed, -contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
  2. Individual/Group Control Stations: Momentary-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center off functions for individual and group control.
    b. Product: Subject to compliance with requirements, provide "Decora Plus" by Leviton

ROLLER WINDOW SHADES
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Manufacturing Co. Inc.

H. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop shade at fully raised and fully lowered positions.

I. Operating Function: Stop and hold shade at any position.

J. Operating Features: Include the following:
   1. Group switching with integrated switch control; single face plate for multiple switch cut-outs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions and located so shade band is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

B. Connections: Connect motorized operators to building electrical system.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain roller shades. Refer to Division 01 Section Demonstration and Training.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Drawing Designation:
B. This Section includes solid surfacing and quartz surfacing for the following:
   1. Counter tops.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Show thickness, finish, layout, and anchorage details. Indicate attachment methods, seams, joint treatments, and supports.
   1. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, and other items installed in countertops for architectural woodwork.
   2. Show seam locations.
   3. Full-size details, edge details, attachments, etc.
   4. Locations and sizes of furring, blocking, including concealed blocking and reinforcement specified in other Sections.
C. Samples for Verification: For the following:
   1. Solid stone surfacing materials, 6 inches square.
   2. Cut sample and seam together for representation of seaming techniques.
   3. Indicate full range of color and pattern variation.

1.4 INFORMATIONAL SUBMITTALS
A. Sustainable Submittals:
   1. Manufacturer’s product data for installation adhesives, including printed statement of VOC content and material safety data sheets.
   2. Product data indicating that materials are regionally manufactured and within 500 miles of the project site.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance Data: Submit manufacturer’s recommended cleaning and maintenance procedures.

1.6 QUALITY ASSURANCE
A. Fabricator Qualifications: Company specializing in fabricating engineered stone surfacing material with minimum 5 years experience.
B. Fire-Test-Response Characteristics: Provide surfacing material with the following surface-burning characteristics (if required by code) as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Class I per ASTM E-84 including:
      a. Flame Spread: 25 or less.

1.7 PROJECT CONDITIONS
A. Field Measurements: Where surfacing is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 WARRANTY
A. Manufacturer’s 10 year warranty against defects in materials. Warranty shall provide material and labor to repair or replace defective materials. Damage caused by physical or chemical abuse or damage from excessive heat will not be warranted.
PART 2 - PRODUCTS

2.1 SOLID SURFACING – QUARTZ SURFACING (SM)
A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following: Refer to drawing A5.01.

2.2 MATERIALS
A. Solid Surfacing: Nonporous surfacing material composed of a unique blend of natural minerals and high-performance acrylic meeting the following criteria:
1. Wear and Cleanability: Passes per ASI Z124.3.
2. Abrasion Resistance: No loss of pattern per NEMA LD3-3.01 and ANSI Z 124.3; weight loss, 1,000 cycles, 0.2 gm; wear, 10,000 cycles, 0.008 inches.
3. Boiling Water Surface Resistance: No change per NEMA LD3-3.05.
4. High Temperature Resistance: No change per NEMA LD3-3.06.
5. Conductive Heat Resistance: No change per NEMA LD3-3.08.
6. Impact Resistance, Notched Izod: 0.28 ft-lbs/in of notch per ASTM D 256, Method A.
7. Impact Resistance, Ball Drop: 3/4 inch thick sheet, 36 inches with 1/2 pound ball, no failure per NEMA LD3-3.03.
8. Stain Resistance: Passes, Rating-41, modified with additional stains used, per ANSI Z124.3.
9. Weatherability: No change, 1000 hours, per ASTM D 1499.
10. Fungi and Bacteria: No attack per ASTM G 21, G 22.
11. Water Absorption: 3/4 inch sheet, 0.04 percent after 24 hours, 0.94 percent long term, per ASTM D 570.
12. Flammability: Solid colors per ASTM E 84.
   a. Flame Spread: Less than 5.
   b. Smoke Developed: Less than 15.
   c. Class Rating: 1.
13. Thickness: As scheduled.
14. Colors and Sheen: As scheduled.
B. Quartz Surfacing Material: Nonporous, sound, hard, durable, heat resistant engineered stone meeting the following criteria:
2. Izod Impact Strength (ASTM D 256): Average 0.361 ft.lbs/inch of notch.
3. Impact Strength (2 lb. Ball from 8’-0”): Passed.
4. Liquid Absorption (ASTM C 97): 0.022 percent.
5. Surface Burning Characteristics (ASTM E 84):
7. Thickness: As scheduled.
8. Appearance, Color, and Sheen: As scheduled.

2.3 MISCELLANEOUS MATERIALS
A. Adhesives and Cements: Non-staining, type as recommended by engineered stone manufacturer.
1. Waterproof, permanent material which will not induce mildew and fungus growth.
B. Joint Sealants: Two part color matched polyester knife grade adhesive.
C. Special Features: Provide edge treatments as detailed in Drawings.

2.4 FABRICATION
A. Assemble work at shop and deliver to job ready for installation. Manufacture in largest practical lengths with seams in least conspicuous locations.
B. Fabricate work square and to required lines.
C. Recess and conceal fasteners, connections, and reinforcing.
D. Design construction and installation details to allow for expansion and contraction of materials. Properly frame material with tight, hairline joints held rigidly in place.
E. Comply with adhesive manufacturer's recommendations for adhesive shelf life, pot life, working life, mixing, spreading, assembly time, time under pressure and ambient temperatures.
F. Fabricate countertops with backsplash and side splashes to profiles indicated or detailed.
G. Fabricate items to profiles shown with connections and supports as detailed or as required for proper installation per manufacturer's recommendations.

I. Do not exceed manufacturer's recommended unsupported overhang distances.

J. Finish exposed surfaces smooth and polish to a sheen indicated.

K. Radius corners and edges.

L. Special Features: Provide edge treatments and other detailed features.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's printed instructions and approved shop drawings. Provide templates and rough-in measurements.

B. Install surfacing true in line and plane, level, rigid and solidly adhered to substrate.

C. Pre-fit items: Adjust supports to make fit. Align joints over support framing.
   1. Provide intermediate supports such that material will not span more than 3 feet in any direction.
   2. Cantilevers shall not exceed 12 inches without supplementary support.

D. Apply dabs of mastic on supports; place items on supports and attach.

E. Install with minimum number of joints practical, using full-length pieces from maximum lengths available. Cope at returns and square at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Radius cutouts with minimum 3/8 inch corner radius.

F. Install splashes using adhesive. Apply adhesive to back surface only. Place thin bead of seam adhesive along edge where splashes seat.

3.2 TOLERANCES

A. Variation in Component Size: Plus or minus 1/8 inch over 10'-0" length.

B. Location of Openings: Plus or minus 1/8 inch from indicated location.

C. Install countertops level to within 1/8 inch in 10 feet.

D. Allow minimum 1/16 inch clearance between edges of countertops and adjacent walls.

E. Maximum Offset From True Position: 1/8 inch.

3.3 CLEANING

A. Clean work under provisions of Section 017700.

B. Clean and polish fabrications in accordance with manufacturer's instructions.

END OF SECTION
SECTION 210500

COMMON WORK RESULTS FOR FIRE SUPPRESSION

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 project is a renovation and expansion of an existing fire suppression system. Work will require
      relocation of the existing riser, additional fire protection piping heads, etc. The existing system will need to
      remain in place and fully functional during the renovation and then switched over to the new locations and
      existing piping will need to be reconnected. Phasing work is required.
   B. This Section includes the following:
      1. Piping materials and installation instructions common to most piping systems.
      2. Mechanical sleeve seals.
      3. Sleeves.
      4. Escutcheons.
      5. Grout.
      6. Fire-suppression equipment and piping demolition.
      7. Equipment installation requirements common to equipment sections.
      8. Painting and finishing.
      9. Concrete bases.
     10. Supports and anchorages.

1.3 DEFINITIONS
   A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe
      chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces.
   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, under entry canopy.
   D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building
      occupants. Examples include above ceilings and in chases.
   E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and
      physical contact by building occupants but subject to outdoor ambient temperatures. Examples include
      installations within unheated shelters.
   F. The following are industry abbreviations for rubber materials:
      1. EPDM: Ethylene-propylene-diene terpolymer rubber.
      2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS
   A. Product Data: For the following:
      1. Mechanical sleeve seals.
      2. Escutcheons.
   B. Drawing – Head layout, piping sizes, piping layout, piping and head elevations, flow devices double check,
      valves, riser.

1.5 QUALITY ASSURANCE
   A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding
      Code--Steel."
   B. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics
      may be furnished provided such proposed equipment is approved in writing and connecting electrical
      services, circuit breakers, and conduit sizes are appropriately modified and overall capacity of system is
      not lowered. If minimum energy ratings or efficiencies are specified, equipment shall comply with
      requirements.
1.6 COORDINATION
A. Design will be based on symmetrical spacing of fire sprinkler heads minimum of 12” from all HVAC diffusers and grilles. Coordinate all locations within ceiling plan of architectural plan.
B. Architect has final approval of all head locations.
C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
E. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section “Access Doors and Frames.”

PART 2 - PRODUCTS

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

2.2 PIPE, TUBE, AND FITTINGS
A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS
A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      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. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
D. Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MECHANICAL SLEEVE SEALS
A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Calpico, Inc.
      b. Metrarelax Co.
      c. Pipeline Seal and Insulator, Inc.
      d. Hilti.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES
A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
C. Cast Iron: Cast or fabricated “wall pipe” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
D. 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 set screws.

2.6 ESCUTCHEONS
A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with white finish.
C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Ceilings - White

2.7 GROUT
A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION
3.1 PIPING SYSTEMS - COMMON REQUIREMENTS
A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
B. Contractor to perform a site visit to determine existing piping location and heights. Provide all design and installation to adjust existing piping to accommodate new ceiling plan heights and design.
C. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
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. Install piping to permit valve servicing.
H. Install piping at indicated slopes.
I. Install piping free of sags and bends.
J. Install fittings for changes in direction and branch connections.
K. Install piping to allow application of insulation.
L. Select system components with pressure rating equal to or greater than system operating pressure.
M. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with White finish.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type with finish matching color of wall.
N. Sleeves are not required for core-drilled holes.
O. Permanent sleeves are not required for holes formed by removable PE sleeves.
P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to
2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire-stop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.
U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
V. Keep piping as close to roof deck as possible.
W. Center heads in 2x2 ceiling tile. Align heads with arch features in GYP. BRD. Ceilings. Heads shall be located in a Symmetrical pattern and architect shall have final approval of all head locations.

3.2 PIPING JOINT CONSTRUCTION
A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PAINTING
A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 CONCRETE BASES
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 larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section Cast-in-Place Concrete or Miscellaneous Cast-in-Place Concrete.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.6 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 210500
SECTION 211000
WATER-BASED FIRE-SUPPRESSION 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.
B. This project is a renovation and expansion of an existing fire suppression system. Work will require expansion of the existing main piping and additional fire protection piping heads, etc. The existing system will need to remain in place and fully functional during the renovation and then switched over to the new locations and existing piping will need to be reconnected. Phasing work is required.

1.2 SUMMARY
A. This Section includes the following fire-suppression piping inside the building:
   1. Automatic wet-type.
B. Related Sections include the following:
   1. Division 10 Section 104413 "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
   2. Division 28 283111 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.3 DEFINITIONS
A. CR: Chlorosulfonated polyethylene synthetic rubber.
B. PE: Polyethylene plastic.
C. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 SYSTEM DESCRIPTIONS
A. Wet Sprinkler System: Fire-suppression sprinkler systems. Sprinkler system is supplied from riser system.

1.5 PERFORMANCE REQUIREMENTS
B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction. Contractor shall provide a complete fire protection system including all components necessary to insure proper operation and meet code/manufacturer’s requirements. This includes a stand-alone detection system for areas protected by preaction systems.
1. Contractor to perform a site visit to determine existing piping location and heights. Provide all design and installation to adjust existing piping to accommodate new ceiling plan heights and design.
2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications:
   a. Electrical Equipment Rooms: Ordinary Hazard, Group 1
   b. General Storage Areas: Ordinary Hazard, Group 1
   c. Mechanical Equipment Rooms: Ordinary Hazard, Group 1
   d. Office and Public Areas: Light Hazard
   e. Library Stacks Area: Ordinary Hazard Group 1
4. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
5. Maximum Protection Area per Sprinkler: Per UL listing and manufacturers requirements.
6. Maximum Protection Area per Sprinkler:
   a. Storage Areas: 100 sq. ft.
   b. Mechanical Equipment Rooms: 100 sq. ft.
   c. Electrical Equipment Rooms: 100 sq. ft.
   d. Light Hazard Areas: 200 sq. ft.
   e. Library Stacks Areas: 100 sq. ft.
7. System design areas shall be per the in-force edition of NFPA 13. Adjustment allowances shall be strictly enforced.
8. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm for 30 minutes
   b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes

1.6 SUBMITTALS
A. Product Data: For the following:
   1. Piping materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings.
   2. Pipe hangers and supports
   3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
   4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
   5. Hose connections, including size, type, and finish.
   6. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish. Coordinate with local fire department connection requirements.
   7. Alarm devices, including electrical data.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.
D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14 Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
E. Welding certificates.
F. Field quality-control test reports.
G. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE
A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems. Base calculations on results of fire-hydrant flow test combined with fire pump.
B. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 230, "Fire Protection of Storage."

1.8 COORDINATION
A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
B. Coordinate any electrical requirements for sprinkler systems with electrical contractor.

1.9 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the
manufacturers specified.

2.2 STEEL PIPE AND FITTINGS
A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.
   5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
   1. Grooved-Joint Piping Systems:
      a. Manufacturers:
         1) Central Sprinkler Corp.
         2) Star Pipe Products; Star Fittings Div.
         3) Victaulic Co. of America.
      b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
      c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.
C. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.
   1. Grooved-Joint Piping Systems:
      a. Manufacturers:
         1) Central Sprinkler Corp.
         2) Star Pipe Products; Star Fittings Div.
         3) Victaulic Co. of America.
      b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
      c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 FLEXIBLE CONNECTORS
A. Flexible connectors shall have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:
   1. NPS 2 and Smaller: Threaded.
   2. NPS 2-1/2 and Larger: Flanged.
   3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.
B. Manufacturers:
   1. Flex-Hose Co., Inc.
   2. Flex-Weld, Inc.
   4. Metraflex, Inc.
C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

2.4 SPRINKLER SPECIALTY FITTINGS
A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.
B. Outlet Specialty Fittings:
   1. Manufacturers:
      a. Central Sprinkler Corp.
b. Star Pipe Products; Star Fittings Div.
c. Victaulic Co. of America.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
1. Manufacturers:
   a. Central Sprinkler Corp.
   b. Fire-End and Croker Corp.
   c. Viking Corp.

D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
1. Manufacturers:
   b. Fire-End and Croker Corp.
   c. Potter-Roemer; Fire-Protection Div.

E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
1. Manufacturers:
   a. AGF Manufacturing Co.
   b. Central Sprinkler Corp.
   c. G/J Innovations, Inc.

F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
1. Manufacturers:
   a. CECA, LLC.
   b. Merit.

G. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.5 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

B. Ball Valves: Comply with UL 1091, except with ball instead of disc.
1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
3. NPS 3: Ductile-iron body with grooved ends.
4. Manufacturers:
   a. NIBCO.
   b. Victaulic Co. of America.

C. Butterfly Valves: UL 1091.
1. NPS 2 and Smaller: Bronze body with threaded ends.
   a. Manufacturers:
      1) Global Safety Products, Inc.
      2) Milwaukee Valve Company.
      3) Nibco
2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
   a. Manufacturers:
      1) Central Sprinkler Corp.
      2) Global Safety Products, Inc.
      3) McWane, Inc.; Kennedy Valve Div.
      4) Mueller Company.
      5) NIBCO.
      6) Victaulic Co. of America.

D. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Manufacturers:
   a. Central Sprinkler Corp.
   b. Clow Valve Co.
   c. Crane Co.; Crane Valve Group; Crane Valves.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Globe Fire Sprinkler Corporation.
   f. Grinnell Fire Protection.
   g. Hammond Valve.
   h. McWane, Inc.; Kennedy Valve Div.
i. Mueller Company.
j. NIBCO.
k. Potter-Roemer; Fire Protection Div.
l. Reliable Automatic Sprinkler Co., Inc.
m. Star Sprinkler Inc.
n. Stockham.
o. United Brass Works, Inc.
p. Victaulic Co. of America.
q. Watts Industries, Inc.; Water Products Div.

E. Gate Valves: UL 262, OS&Y type.
1. NPS 2 and Smaller: Bronze body with threaded ends.
   a. Manufacturers:
      1) Crane Co.; Crane Valve Group; Crane Valves.
      2) Hammond Valve.
      3) NIBCO.
      4) United Brass Works, Inc.
2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
   a. Manufacturers:
      1) Clow Valve Co.
      2) Crane Co.; Crane Valve Group; Crane Valves.
      3) Crane Co.; Crane Valve Group; Jenkins Valves.
      4) Hammond Valve.
      5) Milwaukee Valve Company.
      6) Mueller Company.
      7) NIBCO.
      8) Red-White Valve Corp.
      9) United Brass Works, Inc.

F. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch.
2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
   a. Manufacturers:
      1) Milwaukee Valve Company.
      2) NIBCO.
      3) Victaulic Co. of America.
3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
   a. Manufacturers:
      1) Central Sprinkler Corp.
      2) Grinnell Fire Protection.
      3) McWane, Inc.; Kennedy Valve Div.
      4) Milwaukee Valve Company.
      5) NIBCO.
      6) Victaulic Co. of America.

2.6 SPRINKLERS
A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum pressure rating if sprinklers are components of high-pressure piping system.
B. Replace all existing sprinkler heads with new heads in existing areas renovated and not renovated.
C. Manufacturers:
   1. Central Sprinkler Corp.
   4. Reliable Automatic Sprinkler Co., Inc.
   5. Star Sprinkler Inc.
   6. Victaulic Co. of America.
   7. Viking Corp.
D. Store sprinkler system components in their original shipping container, in a clean, dry space protected from weather. Until completion of all finish-out, protective caps/clips shall not be removed from sprinklers or cover plates/escutcheon plates installed. Any painted sprinklers or cover plates shall be replaced.
E. Fire sprinklers shall be of one manufacturer throughout the protected area. No mixing of sprinkler brands shall be permitted. Utilization of non-metal parts in the sealing portion of the sprinkler is strictly prohibited.
F. Automatic Sprinklers: With heat-responsive element complying with the following:
   1. UL 1767, for early-suppression, fast-response applications.

G. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
      a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
      b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.

H. Sprinkler types, features, and options as follows:
   1. Concealed ceiling sprinklers, including cover plate.
   2. Extended-coverage sprinklers.
   3. Institution sprinklers, made with a small, breakaway projection.
   4. Quick-response sprinklers.
   5. Recessed sprinklers, including escutcheon.
   7. Sidewall, dry-type sprinklers.
   8. Upright sprinklers.

I. Sprinkler Finishes: Painted white for ceiling installations and black for exposed. Confirm all colors with architect.

J. Special Coatings: Wax, lead, and corrosion-resistant paint.

K. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications.
   Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: Factory painted white steel, one piece, flat
   2. Sidewall Mounting: Factory painted to match wall color steel one piece, flat.

L. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. Guards shall be listed with the sprinkler they are installed on.

2.7 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch-diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.
   1. Manufacturers:
      a. Central Sprinkler Corp.
      c. Grinnell Fire Protection.
      d. Reliable Automatic Sprinkler Co., Inc.
      e. Star Sprinkler Inc.
      f. Viking Corp.

C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   1. Manufacturers:
      b. Potter Electric Signal Company.
      c. Viking Corp.

D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
   1. Manufacturers:
      b. Potter Electric Signal Company.
      c. Viking Corp.

E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
   1. Manufacturers:
      a. McWane, Inc.; Kennedy Valve Div.
      b. Potter Electric Signal Company.
F. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.
   1. Manufacturers:

2.8 PRESSURE GAUGES
A. Manufacturers:
   1. AGF Manufacturing Co.
   2. AMETEK, Inc.; U.S. Gauge.
   5. Marsh Bellofram.
   6. WIKA Instrument Corporation.
B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.
   1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
   2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING APPLICATIONS, GENERAL
A. Shop weld pipe joints where welded piping is indicated.
B. Do not use welded joints for galvanized-steel pipe.
C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
E. Underground Service-Entrance Piping: Ductile-iron, grooved-end pipe and fittings; grooved-end-pipe couplings; and grooved joints.

3.3 VALVE APPLICATIONS
A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14
      a. Shutoff Duty: Use ball, butterfly, or gate valves.

3.4 JOINT CONSTRUCTION
A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
B. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
   2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
   4. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.
C. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
   1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.5 PIPING INSTALLATION
A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.
B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints.
D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
E. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
H. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
I. Install drain valves on standpipes.
J. Install alarm devices in piping systems.
K. Hangers and Supports: Comply with NFPA 13 for hanger materials.
   1. Install sprinkler system piping according to NFPA 13.
L. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they will not be subject to freezing.
M. Drain dry-pipe sprinkler piping.
N. Fill wet-pipe sprinkler system piping with water.
O. Install flexible connectors on fire-pump supply and discharge connections and in fire-suppression piping where indicated.

3.6 VALVE INSTALLATION
A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.
B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

3.7 SPRINKLER APPLICATIONS
A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
   1. Rooms without Ceilings: Upright sprinklers
   2. Rooms with Suspended Ceilings: Flush concealed sprinklers.
   4. IT Rooms: Sidewall sprinklers.
   5. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated
   6. Sprinkler Finishes:
      a. Upright, Pendent, and Sidewall Sprinklers: Factory painted white in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
      b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
      c. Recessed Sprinklers: Factory painted white, with white escutcheon.
   7. Provide wire cage in mechanical and electrical rooms, janitor’s closet.

3.8 SPRINKLER INSTALLATION
A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.

B. In other than acoustic tile, align heads with lights, center on architectural elements, space evenly to appear coordinated with other ceiling elements. Minimum of 12” from HVAC and Lighting ceiling equipment.

3.9 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties” for backflow preventers.

D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

F. Electrical Connections: Power wiring is specified in Division 26.

G. Connect alarm devices to fire alarm. Connections specified in Division 26.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.10 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14

3.11 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   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. Energize circuits to electrical equipment and devices.
   4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance” Chapter.
   5. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance” Chapter.
   6. Coordinate with fire alarm tests. Operate as required.
   7. Coordinate with fire-pump tests. Operate as required.
   8. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.12 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

3.13 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 220500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Piping materials and installation instructions common to most piping systems.
      2. Transition fittings.
      3. Dielectric fittings.
      4. Sleeves.
      5. Escutcheons.
      7. Plumbing demolition.
      8. Equipment installation requirements common to equipment sections.
      10. Concrete bases.
      11. Supports and anchorages.

1.3 DEFINITIONS
   A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
   B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
   C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
   D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
   E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
   F. The following are industry abbreviations for plastic materials:
      1. CPVC: Chlorinated polyvinyl chloride plastic.
      2. PE: Polyethylene plastic.
      3. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS
   A. Product Data: For the following:
      1. Transition fittings.
      2. Dielectric fittings.
      3. Escutcheons.
      4. Piping
   B. Submittal Items: Submittal items shall be inserted in a Technical Information Brochure. Mark the appropriate specification section or drawing reference number in the right hand corner of each item. All typewritten pages shall be on the product or equipment manufacturer’s printed letterhead.
      1. Manufacturer’s Literature: Where indicated, include the manufacturer’s printed literature. Literature shall be clearly marked to indicate the item intended for use.
      2. Performance Data: Provide performance data, wiring and control diagrams and scale drawings which show that proposed equipment will fit into allotted space (indicate areas required for service access, connections, etc.), and other data required for the Architect to determine that the equipment complies with the Contract Documents. Where noted, performance data shall be certified by the manufacturer at the design rating points.

COMMON WORK RESULTS FOR PLUMBING
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3. Installation Instructions: Where requested, each product submittal shall include the manufacturer's installation instructions. Generic installation instructions are not acceptable. Instructions shall be the same as those included with the product when it is shipped from the factory.

4. Written Operating Instructions: Instructions shall be the manufacturer's written operating instructions for the specified product. If the instructions cover more than one model or type of product they shall be clearly marked to identify the instructions that cover the product delivered to the project. Operating Instructions shall be submitted immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".

5. Maintenance Instructions: Information shall be the manufacturer's printed instructions and parts lists for the equipment furnished. If the instructions cover more than one model or type of equipment they shall be marked to identify the instructions for the furnished product. Submit maintenance instructions immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".

1.5 QUALITY ASSURANCE
   A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
   B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
      1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
      2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
   C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. Equipment provided shall meet or exceed the IECC 2015 minimum efficiency requirements.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
   B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION
   A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
   B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
   C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS
   A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
   B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS
   A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
   B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
   C. Solvent Cements for Joining Plastic Piping:
      1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 TRANSITION FITTINGS
   A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
      1. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
   B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
2.4  DIELECTRIC FITTINGS
   A.  Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
   B.  Insulating Material: Suitable for system fluid, pressure, and temperature.
   C.  Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
   D.  Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
      1.  Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
   E.  Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

2.5  SLEEVES
   A.  Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
   B.  Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2.6  ESCUTCHEONS
   A.  Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
   B.  One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
   C.  One-Piece, Cast-Brass Type: With set screw.
      1.  Finish: Polished chrome-plated and rough brass.
   D.  Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
      1.  Finish: Polished chrome-plated and rough brass.
   E.  One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
   F.  Split-Plate, Stamped-Steel Type: With hinge, set screw or spring clips, and chrome-plated finish.

2.7  GROUT
   A.  Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
      2.  Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1  PLUMBING DEMOLITION
   A.  Refer to Division 01 Section "Cutting and Patching" for general demolition requirements and procedures.
   B.  Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
      1.  Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
      2.  Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
      3.  Equipment to Be Removed: Disconnect and cap services and remove equipment.
      4.  Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
      5.  Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
   C.  If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2  PIPING SYSTEMS - COMMON REQUIREMENTS
   A.  Install piping according to the following requirements and Division 22 Sections specifying piping systems.
   B.  Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing. Valves located above ceilings shall be positioned no further than arms length away from accessible ceiling opening.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. 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.
   2. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

3.4 PIPING CONNECTIONS
A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS
A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING
A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections 099100 Painting.
B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES
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 larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. As specified in Division 03 Section.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES
A. Refer to Division 05 Section “Metal Fabrications” for structural steel.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES
A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor plumbing materials and equipment.
B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
C. Attach to substrates as required to support applied loads.
3.10 GROUTING
A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

END OF SECTION
SECTION 220519

METERS AND GAUGES 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. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Pressure Reducing Valves

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Product Certificates: For each type of meter from manufacturer.
C. Operation and Maintenance Data: For meters to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS
A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. REOTEMP Instrument Corporation.
   b. Trerice, H. O. Co.
   c. Weiss Instruments, Inc.
   d. WIKA Instrument Corporation - USA.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Back angle or Straight unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass.
8. Stem: Aluminum or brass and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS
A. Thermowells:
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
B. Heat-Transfer Medium: Mixture of graphite and glycerin.
2.3 PRESSURE GAUGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gauges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMETEK, Inc.; U.S. Gauge.
      b. Ashcroft Inc.
      c. Marsh Bellofram.
      d. Trerice, H. O. Co.
      e. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
      f. Weiss Instruments, Inc.
      g. WIKA Instrument Corporation - USA.
   3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch or 6-inch nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
   10. Ring: Brass or Stainless steel.
   11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
G. Install isolation valve at building entry with pressure reducing valve and pressure gauges at inlet/exit of PRV.
H. Install valve and snubber in piping for each pressure gauge for fluids.
I. Install thermometers in the following locations: (May not be shown on drawings)
   1. Inlet and outlet of each water heater.
   2. Outlet of all mixing valves.
J. Install pressure gauges in the following locations: (May not be shown on drawings)
   1. Building water service entrance into building.
   2. Inlet and outlet of each pressure-reducing valve.

3.2 CONNECTIONS

A. Install gauges adjacent to machines and equipment to allow service and maintenance.

3.3 ADJUSTING

A. Adjust faces of meters and gauges to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F.
B. Scale Range for Domestic Hot-Water Piping: 0 to 150 deg F.

3.5 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Water Piping: 0 to 100 psi.
SECTION 220523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following general-duty valves:
   1. Copper-alloy ball valves.
   2. Bronze check valves.
   3. Wall hydrants. (Freeze proof with anti-siphon vacuum breakers.)
B. Related Sections include the following:
   1. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and charts.
   2. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS
A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. PTFE: Polytetrafluoroethylene plastic.
   4. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS
A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE
A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
B. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL
A. Refer to Part 3 "Valve Applications" Article for applications of valves.
B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
D. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
E. Extended Valve Stems: On insulated valves.
F. Valve Ends:
   1. Solder Joint: With sockets according to ASME B16.18.
      a. Caution: Use solder with melting point below 840 deg F for globe valves; below 421 deg F for ball valves.
   2. Threaded: With threads according to ASME B1.20.1.

2.3 COPPER-ALLOY BALL VALVES
A. Manufacturers:
   1. Full Port Ball Valve, Copper-Alloy Ball Valves:
      b. Crane Co.; Crane Valve Group; Stockham Div.
      c. Kitz Corporation of America.
      d. NIBCO INC.
B. Copper-Alloy Ball Valves, General: MSS SP-110.
C. Full Port Ball Valve, Copper-Alloy Ball Valves: Brass or bronze body with chrome-plated bronze ball, PTFE or TFE seats, and 400-psig minimum CWP rating.

2.4 BRONZE SWING CHECK VALVES
A. Class 125, Bronze Swing Check Valves with Bronze Disc:
   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. Milwaukee Valve Company.
      c. NIBCO INC.
      d. Powell Valves.
      e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow.
      e. Ends: Threaded.
      f. Disc: Bronze.

2.5 WALL HYDRANTS
A. Nonfreeze Wall Hydrants:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      c. Watts Drainage Products Inc.
      d. Woodford Manufacturing Company.
      e. Zurn Plumbing Products Group; Light Commercial Operation.
   4. Operation: Loose key.
   5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   6. Inlet: NPS 3/4 or NPS 1.
   7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   8. Box: Deep, flush mounting with cover, wall flange and drip lip.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after 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 in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
D. Examine threads on valve and mating pipe for form and cleanliness.
E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball valves.
   2. Check Valves: Bronze check valves.
   3. Outdoor Hose Connection: Wall Hydrants
B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.
C. Domestic Water Piping: Use the following types of valves:
   1. Full Port Ball Valve, Copper-Alloy.
   2. Bronze Check Valves
   3. Wall Hydrant
D. Select valves, except wafer and flangeless types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install valves with unions at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
C. Locate valves for easy access and provide separate support where necessary.
D. Install valves in horizontal piping with stem at or above center of pipe.
E. Install valves in position to allow full stem movement.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following hangers and supports for plumbing system piping and equipment:
1. Steel pipe hangers
2. Trapeze pipe hangers.
3. Pipe positioning systems.
B. Related Sections include the following:
1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.

1.3 DEFINITIONS
A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS
A. Product Data: For the following:
1. Steel pipe hangers
2. Trapeze pipe hangers
3. Pipe positioning systems
B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Steel pipe hangers. Include product data (including load capacities) for components.
2. Trapeze pipe hangers. Include product data (including load capacities) and installation data.
3. Pipe positioning systems. Include product (including load capacities) and installation data.
C. Welding certificates.

1.5 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
ASME Boiler and Pressure Vessel Code: Section IX.
B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
3. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified

2.2 STEEL PIPE HANGERS
A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
B. Manufacturers:
2. Empire Industries, Inc.
3. ERICO/Michigan Hanger Co.
4. Grinnell Corp.
5. PHD Manufacturing, Inc.
6. Tolco Inc.
C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

2.3 TRAPEZE PIPE HANGERS
A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.
B. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
C. Manufacturers:
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Samco Stamping, Inc.

2.4 PIPE POSITIONING SYSTEMS
A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.
B. Manufacturers:
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Approved equal.

2.5 MISCELLANEOUS MATERIALS
A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS
A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized, metallic coatings.
D. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
E. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
G. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
H. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

I. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

J. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

K. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. The building is a steel framed structure. Attachment to the building structure will be by Clamp Connection to Steel Beams: B-Line, Grinnell, Superstrut, or equal, beam clamp with retaining clip style as required by load.

D. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install building attachments to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping.

H. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections. Galvanized Surfaces: Clean
welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529
SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Valve tags.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.

1.4 COORDINATION
A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS
A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Fasteners: Stainless-steel rivets or self-tapping screws.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
B. Label Content: Include equipment's Drawing designation or unique equipment number.
C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS
A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches.

2.3 VALVE TAGS
A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.
B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION
A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION
A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.
C. Locate labels on access doors and ceiling guards for concealed equipment, valves, etc.

3.3 PIPE LABEL INSTALLATION
A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.

3.4 VALVE-TAG INSTALLATION
A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape: 2 inches round brass tag with stamped or engraved lettering.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Insulation Materials:
         a. Flexible elastomeric.
         b. Mineral fiber.
      2. Adhesives.
      3. Sealants.
      4. Factory-applied jackets.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets
      (both factory and field applied, if any).
   B. Submittal:
      1. For adhesives and sealants, including printed statement of VOC content compliant with South
         Coast Air Quality Management District (SCAQMD) Rule #1168.

1.4 QUALITY ASSURANCE
   A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or
      another craft training program certified by the Department of Labor, Bureau of Apprenticeship and
      Training.
   B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response
      characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and
      inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket
      materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of
      applicable testing and inspecting agency.
      1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50
         or less.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM
      standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION
   A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section
      "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.

1.7 SCHEDULING
   A. Schedule insulation application after pressure testing systems. Insulation application may begin on
      segments that have satisfactory test results.
   B. Complete installation and concealment of plastic materials as rapidly as possible in each area of
      construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS
   A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
PLUMBING INSULATION

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B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. 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.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

D. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000(Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

2.3 SEALANTS

A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F.

B. ASJ Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

2.4 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.
2.5 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. 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.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lb/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment 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. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere and seal patches similar to butt joints.
O. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.
3.4 PENETRATIONS
A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION
A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

3.6 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 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.

3.7 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.
   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. Secure insulation materials with wire or bands.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.8 PIPING INSULATION SCHEDULE, GENERAL
A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.9 INDOOR PIPING INSULATION SCHEDULE
A. Existing piping in renovation areas shall be reviewed to determine existing insulation meets specification requirements. Provide all labor and material to install all missing insulation on existing piping.
B. Domestic Hot and Recirculated Hot Water:
   1. Insulation shall be one of the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Stormwater and Overflow:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: minimum ½" thick.

D. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: minimum ½" thick.

E. Condensate and Equipment Drain Water:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4 inch thick.

END OF SECTION
SECTION 220800

COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
B. Related Sections: Refer to Division 01 Section 019114 "General Commissioning Requirements for additional commissioning scope and requirements. All testing and commissioning requirements of that section shall be met.
C. The Commissioning Team will include representatives of the Owner, Design A/E, General Contractor and Installing Subcontractors, BAS Subcontractor and Commissioning Authority (CxA).
D. Scope of Plumbing equipment and systems commissioning
   1. Water heating equipment, heat exchangers, associated pumping and controls

1.2 CONTRACTOR'S RESPONSIBILITIES
A. Attend the Commissioning Kick-off meeting and other Commissioning meetings as required.
B. Attend construction phase coordination meetings.
C. Attend review and coordination meetings.
D. Complete Pre-Functional Checklists (PFCs) for all systems and equipment to be commissioned. Sign and submit the PFC's using the submittal process for tracking. The checklists should be completed and signed by the technician performing the work. Sampling is not permitted; 100% of all equipment shall be tested.
E. Submit completed manufacturer’s start-up checklists for the equipment being commissioned.
F. Provide meters, gauges and instruments for Functional Performance Testing.
G. Perform all commissioning tests at the direction of the CxA.
H. Complete tasks required to correct items noted by the CxA in the Deficiency Log.
I. Participate in systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
J. Provide O&M data including warranties, tables, recommended maintenance schedules, checklists, spare parts lists, wiring and parts diagrams, points of contact for service, for all equipment, systems and controls being commissioned.
K. Provide information requested by the CxA for final commissioning documentation.

1.3 CxA's RESPONSIBILITIES
A. Provide Project-specific construction checklists and commissioning process test procedures for the Plumbing systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
B. Provide a Commissioning Plan.
C. Provide Pre-Functional Checklists.
D. Provide Functional Performance Checklists.
E. Direct commissioning testing.
F. Maintain and distribute the deficiency logs.
G. Provide a Preliminary Commissioning Report to the Owner a minimum of 10 days prior to Final Inspection. The General Contractor will ensure that a copy of the draft report is available on site for review by the building official. The preliminary report shall include the following as a minimum:
   • Results of the mechanical and service water heating testing in separate sections for independent review.
   • Itemized deficiencies found during testing that have not yet been corrected at the time the report is issued.
   • Tests that cannot be completed at the time of report preparation, and reasons that the testing could not be completed.
H. Review the O&M documents for clarity and completeness.
I. Review the O&M Manual that is prepared by the General Contractor and provided to the Owner and includes the following:
   • Submittal data stating selected size and options for each piece of equipment.
   • Name and address of at least one qualified service agency.
   • Service water controls system maintenance and calibration information. Include wiring diagrams, schematics, and control sequences descriptions.
• Desired or field determined setpoints shall be permanently recorded on control drawings at control
devices or, for digital control systems, in the programming instructions.

J. Provide a Final Commissioning Report. The final report shall include the following as a minimum:
• Results of the Functional Performance Tests.
• Disposition of deficiencies found during testing, including the details of corrective measures used or
  proposed.
• Functional performance tests procedures during the commissioning process, including measurable
criteria for test acceptance, provided for repeatability.

1.4 PROCESS
A. Functional Performance Testing will commence after preliminary punch list items are completed by the
Contractor. Functional Performance Testing will not be scheduled until the completed Pre-Functional
Checklists are received by the Commissioning Authority. Functional Performance Testing will not be
scheduled until the draft TAB Report is reviewed by the CxA and Approved by the Engineer of Record.

1.5 SUBMITTALS
A. Certificate of Readiness indicating the Plumbing systems are ready for Commissioning.
B. Completed Pre-Functional Checklists shall be provided as a submittal for tracking purposes. Pre-
  Functional Checklists shall be completed and signed by the technician performing the work. Sampling is
  not permitted for the completion of the Pre-Functional Checklists.
C. Manufacturer’s start-up checklists.
D. Flushing and pressure test reports.
E. Disinfection Reports.
F. Sixty (60) days before any plumbing equipment testing is conducted, provide an overall testing plan and
  schedule for plumbing systems that lists the equipment, modes to be tested, dates of testing and parties
  required to conduct the test. Put this information in to the master construction schedule. Keep the plan and
  schedule updated.

1.6 COMMISSIONING DOCUMENTATION
A. Provide the following information to the CxA:
1. Approved submittals with designer review comments of submittals resolved, operation and
  maintenance manuals, and assistance in preparing the systems manuals, and other documents
  and reports requested by the Commissioning Authority in searchable pdf format
2. Identification of installed systems, assemblies, equipment, and components including design
  changes that occurred during the construction phase on as built markup of the design documents
  (plans and specifications)
3. Process and schedule for completing construction checklists and manufacturer’s prestart and
  startup checklists for Plumbing systems, assemblies, equipment, and components to be verified
  and tested.
4. Completed PFCs certifying that installation, prestart checks, and startup procedures have been
  completed.
5. Schedule indicating when Plumbing systems, subsystems, equipment, and associated controls will
  be ready for functional testing. The date for permanent connection of power is required.
6. Provide, documentation of completion of flushing and pressure test reports and certificates.
7. Corrective action documents.
8. The Contractor shall provide updated “As-Built” single line drawings for the Plumbing systems. The
  drawings are to be provided in the electronic format requested by the CxA.
9. Any additional information requested by the CxA.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL
A. The Contractor shall be responsible for performing procedures presented in specification and contract
  drawings and as detailed in the Functional Performance Tests (FPT). Members of the designated
  Commissioning Team shall witness various portions of the commissioning process. Commissioning Team
  members shall sign-off on appropriate sections after verifying installation, operation, or documentation.
  Final sign-off shall be by the Owner and CxA.
B. Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by the Contractor.
C. Contractor shall provide to the Commissioning Team documentation of calibration of service water heating 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 TESTING PREPARATION
A. Certify in writing the Plumbing systems, subsystems, and equipment and controls have been installed, calibrated, started and are operating per the Contract Documents. Ensure the PFCs are completed and submitted by factory authorized start up tech and submitted to the General Contractor.
B. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
C. Inspect and verify the position of each device and interlock identified in the sequences, control schematics and or on checklists.
D. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
E. Testing Instrumentation: Install measuring instruments and logging devices to record test data if directed by the CxA in the Commissioning Plan.

3.3 GENERAL TESTING REQUIREMENTS
A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.
B. Refer to the Section 019114 General Commissioning Requirements and the commissioning plan for the scope of Plumbing testing.
C. Testing Strategies and Sampling: Refer to the Commissioning Plan for minimum sampling strategies and functional performance test requirements.
D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of controllers and sensors.
E. The CxA shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.
F. The Contractor shall execute the detailed testing plans, procedures, and checklists (PFCs and FPTs) prepared by the CxA for systems, subsystems, and equipment being commissioned.
G. Tests will be performed using design conditions whenever possible.
H. Simulated conditions may need to be imposed when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
I. The CxA may direct that set points be altered to achieve simulated conditions.
J. If tests cannot be completed because of a deficiency outside the scope of the system, the CxA will document the deficiency and report it to the Owner. After deficiencies are resolved, the Contractor will reschedule the tests.

3.4 INSTRUMENTATION
A. Instrumentation for Functional Performance Testing and data recording will be provided by the Contractor. 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 ASPE Standards.

3.5 INSTALLATION VERIFICATION
A. Before system start-up begins, the Contractor shall conduct a final installation verification audit. The Contractor shall be responsible for completion of work including change orders and punch list items to the Owner’s satisfaction.
B. If work is found to be incomplete, incorrect, or non-functional, the Contractor shall correct the deficiency before system start-up work proceeds.

3.6 SYSTEM START-UP & PRE-FUNCTIONAL CHECKLIST
A. System start-up shall be performed by the Contractor in accordance with the manufacturer’s written startup instructions and documented with the Pre-Functional Checklist (PFCs)
   1. Designated members of the Commissioning Team may witness system start-up and list system and equipment deficiencies noted during start-up, however witnessing by the CxA is not required for system start-up and PFC documentation to be performed.

COMMISSIONING OF PLUMBING SYSTEMS
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2. The Contractor shall take corrective action on system deficiencies found or noted and demonstrate and document proper 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.

B. Completed, signed-off PFCs shall be submitted once the system start up is complete for each system.

3.7 FUNCTIONAL PERFORMANCE TESTING

A. The objective of the Functional 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, design intent, and Owner requirements.

B. Functional Performance Testing begins after all PFCs have been completed, submitted, and reviewed by the CxA, and after Test and Balance has been completed.

C. Functional Performance tests for the systems to be commissioned are defined in the Commissioning Plan developed by the commissioning agent. These tests are intended to be conclusive but may require minor modifications as system operation dictates.

1. Draft Functional Performance Test procedures will be provided by the CxA to the Owner, Designers and Contractors for review and comments. Comments will be reviewed and incorporated into the final Functional Performance documents.

2. Final Functional Performance Test documents will be provided for testing.

3. Functional Performance Testing will be executed by the Contractors and witnessed by the CxA.

4. The Commissioning Authority develops specific written equipment, system and assembly Functional Performance Test (FPT’s) procedures for all commissioned Plumbing equipment. The following functions as a minimum will be tested:
   - All modes as described in the sequences of operation.
   - Redundant or automatic back-up modes.
   - Performance of alarms.
   - Mode of operation upon a loss of power and restoration of power.
   - Additional items included in the Functional Performance Test documents provided by the CxA.

5. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 22 Sections. Perform pipe system cleaning, flushing, and hydrostatic testing. Provide cleaning, flushing, testing, and treating completion confirmation and final reports to the CxA.

6. Provide technicians, instrumentation, tools, and equipment to test performance of systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item to be tested.

3.8 NON-CONFORMANCE

A. The CxA will record the results of the Functional Performance Tests. All deficiencies, non-conformance issues, or test failures will be noted and reported to the Contractor in a deficiency list or in a punch-list format.

B. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.

C. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owners Representative.

D. Re-testing.

1. If a Functional Performance Test fails, corrections shall be made to the deficient equipment or systems by the Contractor. The systems will be re-tested until they pass the Tests.

2. The time/cost for the CxA to perform any re-testing required because of improper set up of the systems by the Contractor or failed functional or performance tests will be back-charged to the Contractor (who may choose to recover costs from the party responsible for executing faulty equipment start-up/checkout and associated checklists). This includes instances where a specific item was overlooked in the equipment start-up and checkout procedures, reported to have been successfully completed, but determined during Functional Performance testing to be faulty.

3. Any required re-testing by any Contractor or vendor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Under-building slab and above ground domestic water pipes, tubes, fittings, and specialties inside the building.
B. Related Section: NA

1.3 SUBMITTALS
A. Product Data: For the following products:
   1. Backflow preventers and vacuum breakers.

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 PROJECT CONDITIONS
A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Architect, Construction Manager and Owner no fewer than two days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without Architect's, Construction Manager's and Owner's written permission.

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 COPPER TUBE AND FITTINGS
A. Hard copper tube shall be used for domestic water (hot, cold and hot water recirculation) for the building interior.
B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
   2. Copper Threaded Fittings: ASME B1.20.1
   3. 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.

2.3 PVC PIPE AND FITTINGS
A. Schedule 40 PVC shall be used for domestic water supply on building exterior.
B. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
   2. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.4 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. PVC Union Ball Valves:
   1. Description:
      b. Pressure Rating: 150 psig at 73 deg F.
      c. Body Material: PVC.
      d. Body Design: Union type.
      e. End Connections for Valves NPS 2 and Smaller: Detachable, socket.
      f. Ball: PVC; full port.
      g. Seals: PTFE or EPDM-rubber O-rings.
      h. Handle: Tee shaped.

2.5 TRANSITION FITTINGS
A. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
B. Sleeve-Type Transition Coupling: AWWA C219.
C. Plastic-to-Metal Transition Fittings:
   1. Description:
      a. Pressure Rating: 150 psig at 180 deg F.
      b. End Connections: Solder-joint copper alloy and threaded ferrous.
C. Plastic-to-Metal Transition Unions:
   1. Description:
      a. Pressure Rating: 150 psig at 180 deg F.
      b. End Connections: Solder-joint copper alloy and threaded ferrous.

2.6 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. Description:
      a. Pressure Rating: 150 psig at 180 deg F.
      b. End Connections: Solder-joint copper alloy and threaded ferrous.

2.7 PIPING JOINING MATERIALS
A. Hard copper tube joints for cold water shall be made with 95/4.5/.5 tin/copper/silver solder and non-acid solder flux
B. Hard copper tube joints for hot water and recirculating hot water shall be made with 95/5.6/.5 tin/copper/silver solder and non-acid solder flux
C. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   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).

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 according to CDA's "Copper Tube Handbook."
C. Install PVC tubing per the manufacturer's written instructions.
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 unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Q. Install thermometers in hot-water circulation piping. Comply with requirements in Division 22 Section "Meters and Gauges for Plumbing Piping" for thermometers.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

D. 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.

E. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

F. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   2. PVC Piping: Join according to ASTM D 2855.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 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.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: Trapeze hangers with pipe clamps.

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.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for a PVC piping with the following maximum horizontal spacing:
   1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
   2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   4. NPS 6 and greater: 48 inches with 3/4-inch rod.

G. Install supports for vertical PVC piping every 48 inches.

H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

I. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.5 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.

3.6 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 and equipment in accordance with section 220553 identification for plumbing piping and equipment.

3.7 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.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   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.

3.8 CLEANING
A. Clean and disinfect potable and non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
C. Prepare and submit reports of purging and disinfecting activities.
D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
3.9 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, shall be one of the following:
   Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
E. Aboveground domestic water piping, shall be one of the following:

3.10 VALVE SCHEDULE
A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   2. Check valves: Bronze check valves for NPS 2" and smaller.

END OF SECTION
SECTION 221119
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.
   5. Temperature-actuated water mixing valves.
   7. Drain valves.
   8. Water hammer arresters.
   9. Air vents.
   10. Trap Primers
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.

1.3 PERFORMANCE REQUIREMENTS
A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. NSF Compliance:
   2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS
A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Co.
      b. Conbraco Industries, Inc.
      c. FEBCO; SPX Valves & Controls.
      e. Zurn Plumbing Products Group; Wilkins Div.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   5. Inlet and Outlet Connections: Threaded.
B. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. MIFAB, Inc.
      d. Woodford Manufacturing Company.
2. Domestic Water Piping Specialties

- Zurn Plumbing Products Group; Wilkins Div.
- Standard: ASSE 1011.
- Body: Bronze, nonremovable, with manual drain.
- Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
- Finish: Rough bronze chrome plated.

2.2 Backflow Preventers

A. Reduced-Pressure-Principle Backflow Preventers:
- Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- Basis-of-Design Product: Subject to compliance with requirements, provide or a comparable product by one of the following:
  - Ames Co.
  - FEBCO; SPX Valves & Controls.
  - Watts Industries, Inc.; Water Products Div.
  - Zurn Plumbing Products Group; Wilkins Div.
- Standard: ASSE 1013.
- Operation: Continuous-pressure applications.
- Configuration: Refer to Drawings:

2.3 Water Pressure-Reducing Valves

A. Water Regulators:
- Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - Conbraco Industries, Inc.
  - Cla-Val.
  - Watts Industries, Inc.; Water Products Div.
  - Zurn Plumbing Products Group; Wilkins Div.
- Standard: ASSE 1003.
- Pressure Rating: Refer to Drawings.
- Design Outlet Pressure Setting: Refer to Drawings
- Valves for Booster Heater Water Supply: Include integral bypass.

2.4 Balancing Valves

A. Copper-Alloy Calibrated Balancing Valves:
- Basis-of-Design Product: Subject to compliance with requirements, provide or a comparable product by one of the following:
  - Armstrong International, Inc.
  - ITT Industries; Bell & Gossett Div.
  - NIBCO INC.
  - Taco, Inc.
  - Watts Industries, Inc.; Water Products Div.
- Type: valve with two readout ports and memory setting indicator.
- Body: Brass or bronze,
- Size: As indicated on Drawings.
- Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case

2.5 Temperature-Actuated Water Mixing Valves

A. Thermostatic, Water Mixing Valves:
- Basis-of-Design Product: Subject to compliance with requirements, provide or a comparable product by one of the following:
  - Armstrong International, Inc.
  - Bradley Valve Company.
  - Leonard Valve Company.
  - Powers; a Watts Industries Co.
  - Symmons Industries, Inc.
- Primary: ASSE 1017.
- Individual-Fixture, Water Tempering Valves ASSE 1016.
- Type: Refer to Drawings.
- Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
6. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
7. Tempered-Water Setting: Refer to Drawings.
8. Tempered-Water Design Flow Rate: Refer to Drawings.

2.6 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. Screen: Stainless steel with round perforations, unless otherwise indicated.
   4. Drain: Hose valve with threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain

2.7 DRAIN VALVES
A. Ball-Valve-Type, Hose-End Drain Valves:
   3. Ball: Chrome-plated brass.
   6. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.8 WATER HAMMER ARRESTERS
A. Water Hammer Arresters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. PPP Inc.
      c. Sioux Chief Manufacturing Company, Inc.
   3. Type: Copper tube with piston with threaded end connection.
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.9 TRAP PRIMERS
A. Trap Primers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Precision Plumbing Products (PPI Inc.)
      b. Approved equal
   2. Type: Electronic trap priming manifold with NEMA 12 box and cover
   3. Power: 120V/1PH/60HZ
   4. Electrical Components: circuit breaker, test switch, timer, solenoid valve, UL listed.
   5. Distribution units size: ½”.

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.
   3. Do not install bypass piping around backflow preventers unless required by local AHJ.
   4. Install strainer where shown on drawings.
C. Install water pressure regulators with inlet and outlet shutoff valves, strainer, water hammer arrestor, drain valve and pressure gages on inlet and outlet.
D. Install balancing valves in locations where they can easily be adjusted.
E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.
F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
G. Install water hammer arresters in water piping according to PDI-WH 201.

3.2 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. Primary, thermostatic, water mixing 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."

3.3 ADJUSTING
   A. Set field-adjustable pressure set points of water pressure-reducing valves.
   B. Set field-adjustable flow set points of balancing valves.
   C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION
SECTION 221316

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.

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.
C. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS
A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUBLESS CAST-IRON PIPE AND FITTINGS
A. Pipe and Fittings: Per CISPI 301.85
B. Shielded Couplings: ASTM C 1540 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
      a. Manufacturers:
         1) Clamp-All Corp.
         2) Mission Rubber Co.
         3) Husky
         4) Anaco

2.4 PVC PIPE AND FITTINGS
A. Solid-Wall PVC Pipe: Schedule 40 ASTM D 2665, drain, waste, and vent.
   1. PVC Socket Fittings: Schedule 40 ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
B. Solvent Cement and Adhesive Primer:
   1. Use PVC ASTM D 2564 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).

PART 3 - EXECUTION

3.1 EXCAVATION
   A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS
   A. Above ground, soil and waste piping shall be the following:
      1. Hubless cast-iron soil pipe and fittings heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   B. Above ground, vent piping shall be the following:
      1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   C. Underground, soil, waste, and vent piping shall be the following:
      1. Solid-Wall PVC Pipe: Schedule 40 ASTM D 2665, drain, waste, and vent

3.3 PIPING INSTALLATION
   A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
   B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
   C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
   D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
   F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
   G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
      1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
      2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
      3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
   H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
   I. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
   J. 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 with solvent cement conforming to ASTM D 2321.

3.5 HANGER AND SUPPORT INSTALLATION
A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Install individual, straight, horizontal piping runs according to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   3. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6: 60 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
F. Install supports for vertical cast-iron soil piping every 15 feet.
G. Drawings indicate general arrangement of piping, fittings, and specialties.
H. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.6 CLEANING
A. Clean interior of piping. Remove dirt and debris as work progresses.
B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.7 PROTECTION
A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION
SECTION 221319
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. Cleanouts.
2. Floor drains.
B. Related Sections include the following:
1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.3 DEFINITIONS
A. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

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.

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. Metal Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.

2.2 FLOOR DRAINS
A. Cast-Iron Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
B. Deep-Seal Traps:
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.

C. Floor-Drain, Trap-Seal Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

2.3 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. Cleanouts shall be installed per local Plumbing Code.
      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 deep-seal traps on floor drains and other waste outlets, if indicated on drawings.
   H. 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.
   I. Install wood-blocking reinforcement for wall-mounting-type specialties.
   J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
   K. 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.

2.4 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."

2.5 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 221413
STORM DRAINAGE PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following storm drainage piping inside the building:
   1. Pipe, tube, and fittings.
B. Related Sections include the following:
   1. Division 22 Section "Sump Pumps."

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. Storm Drainage Piping.

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.
C. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS
A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS
A. Pipe and Fittings: Per CISPI 301.85
B. Shielded Couplings: ASTM C 1540 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
      a. Manufacturers:
         1) ANACO.
         2) Clamp-All Corp.
         3) Mission Rubber Co.
         4) Husky

2.4 PVC PIPE AND FITTINGS
A. Solid-Wall PVC Pipe: Schedule 40 ASTM D 2665, drain, waste, and vent.
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).

PART 3 - EXECUTION

3.1 EXCAVATION
   A. Refer to Division 31 Section “Earth Moving” for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS
   A. Above ground storm drainage piping shall be one of the following:
      1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
   B. Underground storm drainage piping shall be one of the following:
      C. Solid-Wall PVC Pipe: Schedule 40 ASTM D 2665, drain, waste, and vent.

3.3 PIPING INSTALLATION
   A. Storm sewer and drainage piping outside the building are specified in Civil Specifications “Storm Utility Drainage Piping.”
   B. Basic piping installation requirements are specified in Division 22 Section “Common Work Results for Plumbing.”
   C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section “Storm Drainage Piping Specialties.”
   D. 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. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
   G. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer’s written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
   H. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
      1. Storm Drain: Slope piping per Local Building Code or as shown on drawings.
   I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
   J. Install underground PVC storm drainage piping according to ASTM D 2321.
   K. 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.”
   C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION
   A. Pipe hangers and supports are specified in Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment.” Install the following:
      1. Vertical Piping: MSS Type 8 or Type 42, clamps.
      2. Individual, Straight, Horizontal Piping Runs: According to the following:
         a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
3. Base of Vertical Piping: MSS Type 52, spring hangers.
   B. Install supports according to Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment.”
   C. Support vertical piping and tubing at base and at each floor.
   D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
   E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
      1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
      2. NPS 3: 60 inches with 1/2-inch rod.
      3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
      4. NPS 6: 60 inches with 3/4-inch rod.
      5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
      6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
   F. Install supports for vertical cast-iron soil piping every 15 feet.
   G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer’s written instructions.

3.6 CONNECTIONS
   A. Drawings indicate general arrangement of piping, fittings, and specialties.
   B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
   C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.7 CLEANING
   A. Clean interior of piping. Remove dirt and debris as work progresses.
   B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
   C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION
SECTION 221423
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following storm drainage piping specialties:
   1. Cleanouts.
   2. Through-penetration firestop assemblies.
   3. Roof drains.
   4. Miscellaneous storm drainage piping specialties.
   5. Flashing materials.
B. Related Sections include the following:
   1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.3 DEFINITIONS
B. FOG: Fats, oils, and greases.
C. PE: Polyethylene plastic.
D. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION
A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS
A. Exposed Metal Cleanouts See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. Retain one of three subparagraphs and list of manufacturers below. See Division 01 Section "Product Requirements."
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      c. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping
   5. Closure: Countersunk
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
B. Metal Floor Cleanouts
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      c. Zurn Plumbing Products Group; Light Commercial Operation.
      d. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
   3. Size: Same as connected branch.
STORM DRAINAGE PIPING SPECIALITIES
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2.2 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected pipe.
4. 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. Special Coating: Corrosion resistant on interior of fittings.

2.3 ROOF DRAINS

A. Metal Roof Drains

B. See Division 01 Section "Product Requirements."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Smith Plumbing Products Group; Specification Drainage Operation.
   e. Smith Plumbing Products Group; Light Commercial Operation.
2. Standard: ASME A112.21.2M.
3. Pattern: Roof drain.
5. Dimensions of Body: Refer to drawings.
6. Combination Flashing Ring and Gravel Stop Required
7. Flow-Control Weirs: Not required
8. Outlet: Bottom.
11. Underdeck Clamp Required.
PART 3 - EXECUTION

3.1 INSTALLATION
A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to 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.
C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
E. Install roof drains and overflow drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.
F. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION
A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Joint 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. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION
A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
B. Place plugs in ends of uncompleted piping at end of each day or when work stops.
C. Maintain system in operation during length of construction.

END OF SECTION
SECTION 223300

ELECTRIC COMMERCIAL 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. This Section includes the following electric water heaters:
   1. Domestic storage electric water heaters.
   2. Thermostat Control Instantaneous Water Heaters
   3. Compression tanks.

1.3 SUBMITTALS
A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.
C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.
B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
E. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.5 COORDINATION
A. Coordinate size and location of steel supports with Architectural and Structural Drawings.

1.6 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period(s): From date of Substantial Completion:
      a. Commercial Electric Water Heaters:
         1) Storage Tank: Five years.
         2) Controls and Other Components: Three years.
      b. Compression Tanks: One year.
      c. Instantaneous Water Heaters: One year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.2 COMMERCIAL ELECTRIC WATER HEATERS

A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.

1. Manufacturers:
   b. Lochinvar Corporation.
   d. Smith, A. O. Water Products Company.
   e. State Industries, Inc.
   f. PVI Industries Inc.

2. Storage-Tank Construction: ASME-code, steel horizontal or vertical arrangement.
   a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      1) 1" and Smaller: Threaded ends according to ASME B1.20.1.
      2) Pressure Rating:
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   c. Tank lining material shall be listed for maximum system design temperature, see drawings.

3. 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: Shall be immersion type.
      1) Staging: Input not exceeding 18 kW per step.
   f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, 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 water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

4. Special Requirements: NSF 5 construction.

5. Capacity and Characteristics: (Refer to Drawings)
   a. Electrical Characteristics: (Refer to Drawings)

B. Thermostat-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.

1. Manufacturers:
   a. Chronomite Laboratories, Inc.
   b. IMI Waterheating, Ltd.
   c. Keltech, Inc.
   d. Niagara Industries, Inc.

2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
   b. Pressure Rating: 150 psig
   c. Heating Element: Resistance heating system.
   d. Temperature Control: Thermostat.
   e. Safety Control: High-temperature-limit cutoff device or system.
   f. Jacket: Aluminum or steel with enameled finish or plastic.


4. Capacity and Characteristics:
   a. Temperature Control: Adjustable thermostat.
      1) Flow Rate: 0.5 gpm minimum.
      2) Temperature Setting: 105 deg F.
   b. Electrical Characteristics:
      1) Reference Plumbing Schedule.

2.3 COMPRESSION TANKS

A. 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.
1. Manufacturers:
   a. AMTROL Inc.
   b. Armstrong Pumps, Inc.
   c. Taco, Inc.
   d. Watts Regulator Co.
   e. Wessels Co.

2. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include
      ASME B1.20.1, pipe thread.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings,
      including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

2.4 WATER HEATER ACCESSORIES
   A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with
      ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting
      less than water heater working-pressure rating. Select relief valves with sensing element that extends into
      storage tank.
   B. Drain-Pan Units: Water heater shall be installed in a galvanized steel drain pan of a minimum thickness of
      24 gauge. Electric water heater drain pans may be high impact plastic of at least 0.0625 inch thickness.
   C. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall
      mounting and capable of supporting water heater and water.
   D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to IECC 2015.

2.5 SOURCE QUALITY CONTROL
   A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME
      Boiler and Pressure Vessel Code.
   B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times
      pressure rating.
   C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION
   A. Install tank type water heaters on structural steel mounting brackets or concrete slab, refer to drawings
      and details for requirements.
   B. Install water heaters level and plumb, according to layout drawings, original design, and referenced
      standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices
      needing service are accessible.
   C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief
      valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet,
      with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive
      air gap onto closest floor drain in the same room as water heater.
   D. Install combination temperature and pressure relief valves in water piping for 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 in the same
      room as water heater.
   E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor
      drains.
   F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for
      Plumbing Piping" for thermometers.
   G. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or
      fitting-type heat traps.
   H. Fill water heaters with water.
   I. Charge compression tanks with air.

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 water heaters to allow service and maintenance. Arrange piping for easy removal
      of water heaters.
C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial electric water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 224000

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.

1.2 SUMMARY
A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets.
   2. Flushometers.
   3. Protective shielding guards.
   4. Fixture supports.
   5. Disposers.
   7. Urinals.
   8. Lavatories.
   10. Mop sinks.
   12. Hose Bibbs and Hydrants

1.3 SUBMITTALS
A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
A. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
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.
E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
F. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
H. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.
I. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
J. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
A. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
C. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
D. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
E. Vitreous-China Fixtures: ASME A112.19.2M.
F. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
G. Water-Closet, Flushometer Tank Trim: ASSE 1037.

1.5 WARRANTY
A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
   a. Structural failures of unit shell.
   b. Faulty operation of controls, blowers, pumps, heaters, and timers.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
B. 1 year Warranty Period for Commercial Applications.

PART 2 - PRODUCTS

2.1 REFER TO DRAWINGS FOR SPECIFIC REQUIREMENTS

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
C. Use carrier supports with waste fitting and seal for back-outlet fixtures.
D. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
E. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
F. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
G. Install wall-mounting fixtures with tubular waste piping attached to supports.
H. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
I. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
J. Install counter-mounting fixtures in and attached to casework.
K. Install fixtures level and plumb according to roughing-in drawings.
L. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
M. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
N. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
O. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
P. Install toilet seats on water closets.
Q. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
R. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
S. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
T. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
U. Install disposer in outlet of each sink indicated to have disposer. Install push button control where indicated or in wall adjacent to sink if location is not indicated.
V. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
W. Set mop sinks in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

X. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 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. Connect ice maker with water supply, stop, and appliance water filter.
D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL
A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
E. Install fresh batteries in sensor-operated mechanisms.
F. 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.

3.5 ADJUSTING
A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
B. Operate and adjust disposers, hot-water dispensers and controls. Replace damaged and malfunctioning units and controls.
C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
D. Replace washers and seals of leaking and dripping faucets and stops.
E. Install fresh batteries in sensor-operated mechanisms.
F. Adjust fixture flow regulators for proper flow and stream height.
G. Adjust water cooler temperature settings.

3.6 CLEANING
A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.
B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.
C. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
D. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

3.7 PROTECTION
A. Provide protective covering for installed fixtures and fittings.
B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 230010

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
   A. Basic Requirements: Requirements of the Contract Forms, Conditions of the Contract, Specifications, Drawings, and Addenda and Contract Modifications (the Contract Documents), apply to the requirements of each Section of Division 23.
   B. Conflicts: Nothing contained in this Section shall be construed to conflict in any way with other provisions or requirements of the Contract documents. The intent is that this Section will take precedence. Where differences arise, the Architect shall decide which directions or instructions take precedence.

1.02 SUMMARY
   A. General: Unless an item is specifically mentioned as being provided by others, the requirements of Division 23 Contract Documents shall be completed. The systems, equipment, devices and accessories shall be installed, finished, tested and adjusted for continuous and proper operation. Any apparatus, material or device not shown on the Drawings but mentioned in these Specifications, or vice versa, or any incidental accessories necessary to make the project complete and operational in all respects, shall be furnished, delivered and installed without additional expense to the Owner. Include all materials, equipment, supervision, operation, methods and labor for the fabrication, installation, start-up and tests necessary for complete and properly functioning systems.

1.03 APPLICABLE STANDARDS
   A. Code Compliance: Refer to Division 1. As a minimum, unless otherwise indicated, comply with all rules, regulations, standards, codes, ordinances and laws of local, state and federal governments and the amendments and interpretation of such rules, regulations, standards, codes, ordinances and laws of local, state and federal governments by the authorities having lawful jurisdiction.
   B. ADA: Comply with the requirements of the Americans with Disabilities Act (ADA).
   C. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.
   D. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards indicated.
   E. International Building Code 2015: Conform in strict compliance to the International Building Code (IBC) and the amendments which are enforced by the local authority having jurisdiction.
      1. International Building Code – Mechanical 2015
   F. NATIONAL FIRE PROTECTION (NFPA) Standards (comply with the latest version adopted by local AHJ):
      1. NFPA-54, National Fuel Gas Code
      2. NFPA-70, National Electrical Code
      3. NFPA-72, National Fire Alarm Code
      4. NFPA-90A, Standard for the Installation of Air Conditioning and Ventilation Systems
      5. NFPA-90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems
   G. Notification: Comply with all of the requirements of the Federal "Right-To-Know" Regulations and the Texas "Right-To-Know" Law and provide notification to all parties concerned as to the use of toxic substances.

1.04 DRAWINGS AND SPECIFICATIONS
   A. Intent: The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
   B. Equipment Placement: The drawings are diagrammatic, intended to show general arrangement, capacity and location of various components, equipment and devices. Each location shall be determined by reference to the general building plans and by actual measurements in the building as built. Reasonable
changes in locations ordered by the Architect prior to the performance of the affected Work shall be provided at no additional cost to the Owner.
C. Drawing Scale: Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets, transitions and fittings may not be shown but shall be provided at no additional cost.
D. Conflict: In the event of a conflict, the Architect will render an interpretation in accordance with the General Conditions.

1.05 DEFINITIONS
A. Provide/Install: The word "provide" shall mean furnish, install, connect, test, complete, and leave ready for operation. The word "install" where used in conjunction with equipment furnished by the Owner or under another contract shall mean mount, connect, complete, and leave ready for operation.
B. Concealed: The surface of insulated or non-insulated piping, ductwork or equipment is concealed from view when standing inside a finished room, such as inside a chase or above a ceiling.
C. Exposed: The surface of insulated or non-insulated piping, ductwork or equipment is seen from inside a finished room, such as inside an equipment or air handling unit room.
D. Protected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building but protected from direct exposure to rain by an overhang, eave, in an unconditioned parking garage or building crawl space.
E. Unprotected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building and exposed to rain.
F. Abbreviations: Abbreviations, where not defined in the Contract Documents, shall be interpreted to mean the normal construction industry terminology, as determined by the Architect. Plural words shall be interpreted as singular and singular words shall be interpreted as plural where applicable for context of the Contract Documents.

1.06 SHOP DRAWINGS
A. General: Refer to paragraph entitled "SUBMITTAL" in this section. Include the following data:
1. Shop Drawings:
a. Submit shop drawings for the following:
   (1) Each piping system
   (2) Ductwork systems as defined in Section 233113
   (3) Coordination drawings
   (4) Roof curb installation drawings with equipment and tie-down attachments shown
   (5) Fire and/or fire/smoke damper installation
   (6) Fire stopping of penetrations through rated assemblies
   (7) Hanger and support installation details

1.07 RECORD DRAWINGS
A. Production: Maintain one set of black or blue line on white project record "as-built" drawings at the site. At all times the set shall be accurate, clear, and complete, indicating the actual installation. Record drawings shall be updated weekly to record the present stage of progress. These drawings shall be available to the Architect at all times. Equipment schedules, control diagrams, sequences of operation shall also be updated.
B. Completion: Prior to substantial completion, transfer onto an unmarked second set of drawings all changes, marked in colored pencil, and submit them to the Architect. Upon completion of all punch lists, transfer all "As-Built" conditions to the AutoCAD drawing files, package three (3) print sets of full size drawings and two (2) CDs of the AutoCAD drawing files with associated reference files and submit them to the Architect for review and approval.

1.08 SUBMITTAL
A. General: The provisions of this section are supplemental to the requirements in Division 1, and only apply to the material and equipment covered in Division 23.
B. Time: Submit manufacturer's literature, performance data and installation instructions covered in each Section of Division 23 under an individual letter of transmittal within 30 days after Notice to Proceed unless otherwise indicated.
C. Submitter's Review: All items required for each section shall be reviewed before submittal. Submittal information for each item shall bear a review stamp of approval, indicating the name of the Contractor and Subcontractor (where applicable), the material suppliers, the initials of submitter and date checked. Responsibility for errors or omissions in submittals shall not be relieved by the Architect's review of submittals. Responsibility for submittals cannot be subrogated to material suppliers by Contractors or Subcontractors.
D. Architect's Review: The submittal data shall be reviewed only for general conformance with the design concept of the project and for general compliance with the Contract Documents. Any action indicated is subject to the requirements of the Contract Documents. Reviews of submittal data review shall not include quantities; dimensions (which shall be confirmed and correlated at the job site); fabrication processes; techniques of construction; and co-ordination of the submittal data with all other trades. Copies of the submittal data will be returned marked "ACCEPTED AS SUBMITTED", "ACCEPTED AS NOTED", "REVISED AS NOTED AND RESUBMIT", "REJECTED, REVISED AS NOTED AND RESUBMIT".

E. Submittal Items: Submittal items shall be inserted in a Technical Information Brochure. Mark the appropriate specification section or drawing reference number in the right hand corner of each item. All typewritten pages shall be on the product or equipment manufacturer's printed letterhead. All submittals must be in the format indicated in the 2015 IECC paragraph C408.2.5.2 and supporting sub paragraphs.

1. Manufacturer's Literature: Where indicated, include the manufacturer's printed literature. Literature shall be clearly marked to indicate the item intended for use.

2. Performance Data: Provide performance data, wiring and control diagrams and scale drawings which show that the proposed equipment will fit into allotted space (indicate areas required for service access, connections, etc.), and other data required for the Architect to determine that the equipment complies with the Contract Documents. Where noted, performance data shall be certified by the manufacturer at the design rating points.

3. Installation Instructions: Where requested, each product submittal shall include the manufacturer's installation instructions. Generic installation instructions are not acceptable. Instructions shall be the same as those included with the product when it is shipped from the factory.

4. Written Operating Instructions: Instructions shall be the manufacturer's written operating instructions for the specified product. If the instructions cover more than one model or type of product they shall be clearly marked to identify the instructions that cover the product delivered to the project. Operating Instructions shall be submitted immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".

5. Maintenance Instructions: Information shall be the manufacturer's printed instructions and parts lists for the equipment furnished. If the instructions cover more than one model or type of equipment they shall be marked to identify the instructions for the furnished product. Submit maintenance instructions immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".

F. Substitutions:

1. General: Refer to Division 1. Substitutions may be considered for any product or equipment of a manufacturer. See paragraph entitled "MANUFACTURER" in this Section. Any product or equipment may be submitted for review; however, only one substitution per item will be considered. If a substituted product or equipment item is rejected, provide the specified product or equipment.

   a. Submittal shall include the name of the material or equipment to be substituted, equipment model numbers, drawings, catalog cuts, performance and test data and any other data or information necessary for the Architect to determine that the equipment meets the specification requirements. If the Architect accepts any proposed substitutions, such acceptance will be set forth in writing.

   b. Substituted equipment with all accessories installed or optional equipment where permitted and found acceptable, must conform to space requirements. Substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at no additional expense to the Owner. If the substituted item affects the work of other trades, the Request for Substitution form shall include a list of the necessary modifications.

2. Deviations: The Request for Substitution form shall include a complete list of deviations from the scheduled item stating both the features and functions of the scheduled item and the comparable features and functions of the proposed substitution.

   a. Any deviation not indicated in writing will be assumed to be identical to the specified item even if it is shown otherwise on the submittal data.

   b. If a deviation not listed is found anytime after review and acceptance by the Architect and that deviation, in the opinion of the Architect, renders the substituted item as unacceptable, the item shall be removed and replaced by the scheduled item at no additional cost to the Owner.

   c. The Architect shall retain the right to specify modifications to the substituted item, correcting or adjusting for the deviation, if the Architect deems it to be in the best interest of the Owner.

3. Scheduled Item: A scheduled item is a product or item of equipment indicated in the Contract Documents by manufacturer's name and model number identifying a single item. The manufacturer's trade name for a group of products that does not signify a single item including type, style, quality, performance, and sound rating shall not be classified as a scheduled item. Where more than one
manufacturer and product model number are indicated, each shall be considered as a scheduled item.

4. Form: When a product or item of equipment is proposed as a substitution a "REQUEST FOR SUBSTITUTION" form shall be completed and submitted with the required data. A copy of the form is included after the end of this section.

5. Rejection: Substituted products or equipment will be rejected if, in the opinion of the Architect, the submittal does not meet any one of the following conditions or requirements:
   a. The submittal data is insufficient or not clearly identified. The Architect may or may not request additional information.
   b. The product or equipment will not fit the space available and still provide the manufacturers published service area requirements.
   c. The product or equipment submitted is not equivalent to or better than the specified item. Products or equipment of lesser quality may be considered provided an equitable financial rebate, satisfactory to the Architect, is to be returned to the Owner.
   d. The product or equipment submitted has less capacity, efficiency and safety provisions than the specified item.
   e. The product or equipment submitted does not have warranty, service and factory representation equivalent to that specified.
   f. The Owner prefers not to accept the submitted product.

G. Technical Information Brochure (O&M) Manual:
   1. Binder: Include binders with the first submittal for the Technical Information Brochure. Each binder shall be size 3 inch, hardcover, 3-ring type for 8-1/2" X 11" sheets. Provide correct designation on outside cover and on spine of each binder, i.e., MECHANICAL SUBMITTAL DATA, MECHANICAL OPERATION INSTRUCTION and MECHANICAL MAINTENANCE INSTRUCTIONS.
   2. Number: Submit not less than five sets of binders for each of the three mechanical brochures indicated above. Each set shall consist of a minimum of two binders for submittal data and 1 binder each for operating instructions and for maintenance instructions. Additional binders shall be submitted at the request of the Architect. One set of binders shall be retained by the Architect. Three sets of binders shall be maintained for the Owner and the remaining set shall become the property of the Engineer.
   3. Index: First sheet in each brochure shall be a photocopy of the "Division 23 Index" of the specifications. Second sheet shall list the firm name, address, phone number, superintendent's name for the contractor and all major subcontractors and suppliers associated with the project.
   4. Dividers: Provide reinforced separation sheets tabbed with the appropriate specifications Section reference number for each Section in which submittal data or operation and maintenance instructions is required.
   5. Specifications: Insert a copy of the specifications for each Section and all addenda applicable to the Section between each of the Section dividers.
   6. Submit the O&M manuals using the format indicated in the 2015 IECC, paragraph C408.5.2 and supporting subparagraphs

1.09 SHOP DRAWINGS FOR PIPING SYSTEMS

A. Requirements: Make Shop Drawings for piping systems at a minimum scale of 1/4 inch per foot in Revit 2018 and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
   1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
   2. Fabrication and erection dimensions.
   3. Arrangements and sectional views.
   4. Necessary details, including complete information for making connections to equipment.
   5. Descriptive names of equipment.
   6. Modifications and options to standard equipment required by Contract Documents.

B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and equipment connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.

C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

D. Additional Requirements: See specific Sections for additional requirements.

1.10 SHOP DRAWINGS FOR DUCT SYSTEMS
A. Requirements: Make Shop Drawings for duct systems at a minimum scale of 1/4 inch per foot in Revit 2012 and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
   1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
   2. Fabrication and erection dimensions.
   3. Arrangements and sectional views.
   4. Necessary details, including complete information for making connections to air distribution devices and air handling equipment.
   5. Kinds of materials and finishes.
   6. Descriptive names of equipment.
   7. Modifications and options to standard equipment required.

B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.

C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

D. Additional Requirements: See specific Sections for additional requirements.

1.11 SHOP DRAWINGS FOR ROOF CURB INSTALLATION AND CONNECTION OF ROOFTOP EQUIPMENT
A. Requirements: Make Shop Drawings for roof curb installation at a minimum scale of 1/4 inch per foot in Revit 2018 and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
   1. Architectural and structural backgrounds including but not limited to plans, sections, elevations, details, etc.
   2. Fabrication and erection dimensions.
   3. Arrangements and sectional views.
   4. Necessary details, including complete information for making connections to roof mounted equipment including tie-downs.
   5. Kinds of materials and finishes.
   6. Descriptive names of equipment.
   7. Modifications and options to standard equipment required.

B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.

C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

D. Additional Requirements: See specific Sections for additional requirements.

1.12 SHOP DRAWINGS FOR FIRE DAMPER AND FIRE SMOKE DAMPERS
A. Requirements: Make Shop Drawings for fire damper and fire smoke damper installation at a minimum scale of 1/4 inch per foot in Revit 2018 and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
   1. Architectural and structural backgrounds including but not limited to plans, sections, elevations, details, etc.
   2. Fabrication and erection dimensions.
   3. Arrangements and sectional views.
   4. Necessary details, including complete information for making connections to roof mounted equipment including tie-downs.
   5. Kinds of materials and finishes.
   6. Descriptive names of equipment.
   7. Modifications and options to standard equipment required.
B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.

C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

D. Additional Requirements: See specific Sections for additional requirements.

1.13 SHOP DRAWINGS FOR FIRE STOPPING FOR PENETRATIONS OF RATED ASSEMBLIES

A. Requirements: Make Shop Drawings for fire stopping of through penetrations of rated walls, ceilings and floors at a minimum scale of 1/4 inch per foot in Revit 2018. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
   1. Architectural and structural backgrounds including but not limited to plans, sections, elevations, details, etc.
   2. Fabrication and erection dimensions.
   3. Arrangements and sectional views.
   4. Necessary details, including complete information for making connections to roof mounted equipment including tie-downs.
   5. Kinds of materials and finishes.
   6. Descriptive names of equipment.
   7. Modifications and options to standard equipment required.

B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.

C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

D. Additional Requirements: See specific Sections for additional requirements.

1.14 SHOP DRAWINGS FOR HANGERS AND SUPPORTS

A. Requirements: Make Shop Drawings for hangers and supports for piping and duct systems at a minimum scale of 1/4 inch per foot in Revit 2012 and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
   1. Architectural and structural backgrounds including but not limited to plans, sections, elevations, details, etc.
   2. Fabrication and erection dimensions.
   3. Arrangements and sectional views.
   4. Necessary details, including complete information for making connections to roof mounted equipment including tie-downs.
   5. Kinds of materials and finishes.
   6. Descriptive names of equipment.
   7. Modifications and options to standard equipment required.

B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.

C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

D. Additional Requirements: See specific Sections for additional requirements.

1.15 COORDINATION DRAWINGS

A. General: Provide detailed (minimum 1/4 inch per foot) scaled coordination drawings showing locations and positions of all architectural, structural, (FF&E) equipment, electrical, plumbing, fire protection and mechanical elements for all installations. Provide overlay drawings, prior to beginning work, indicating work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions and other services. Accommodate phasing and
temporary conditions indicated on the contract drawings as necessary to complete the work without disruption to the Owner's use of the existing occupied areas of the building(s).

B. Coordination of Space: Coordinate use of project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs. In finished areas except as otherwise shown, conceal pipes, ducts, and wiring in construction. Coordinate locations of fixtures and outlets with finish elements. Contractor shall provide background drawings showing partitions, ceiling heights, and structural framing locations and elevations, and existing obstructions. Contractor shall resolve major interferences at initial coordination meeting prior to production of coordination drawings.

C. Precedence of Services: In event of conflicts and interferences involving location and layout of work, use the following priority to resolve interferences:

1. Structure has highest priority.
2. Walls and roof systems.
3. Ceiling grid/light fixtures.
4. Gravity drainage lines.
5. Large pipe mains.
6. Major conduit runs
7. Ductwork/diffusers, registers and grilles.
8. Sprinkler heads.
10. Access panels.

D. Drawings shall be developed on Revit 2012, and utilize AIA Standard layering conventions. At the completion of the project construction, the Contractor shall provide two (2) full-sized print sets and two (2) CDs of all drawing files with related reference files representing as-built installations for Architect review. Upon approval that the submitted information is complete, a similar submittal shall be provided to the Owner.

E. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp.

F. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

G. Additional Requirements: See specific Sections for additional requirements.

1.16 MANUFACTURER'S CHECKOUT

A. Start-up and Checkout: At completion of installation and prior to performance verification, a factory-trained representative of the manufacturer shall provide start-up and checkout service. After the performance verification the manufacturer's representative shall examine performance information and check the equipment in operation, and sign "Check-Out Memo" for the record. Submit a copy of Memo on each item of equipment where indicated in individual sections of these specifications for inclusion in each Technical Information Brochure. The "Check-Out Memo" shall be included with the performance verification data. Do not request "Instruction in Operation Conference" or request final inspection until Memos have been submitted and found acceptable.

1.17 INSTRUCTION TO OWNER

A. General: Instructions to the Owner shall be by competent representatives of the manufacturers involved, with time allowed for complete coverage of all operating procedures. Provide classroom instruction and field training in the design, operation and maintenance of the equipment and troubleshooting procedures. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar provisions of the systems. On the date of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.

B. Training Period: Unless otherwise indicated training periods shall encompass the following number of hours of classroom and hands-on instructions with a maximum period of 4 hours per day for either. Mixing classroom instructions and hands on training in the same day is unacceptable.

1. Training periods:
   a. 4 hours Classroom for HVAC Systems
   b. 4 hours Hands-on for HVAC Systems
   c. 8 hours Classroom for BAS Control Systems
   d. 8 hours Hands-on for BAS Control Systems

C. Scheduling: Submit any remaining required items for checking at least one week before final inspection of building. When submittal items are found acceptable, notify Owner, in writing, that an "Instruction in
Operation Conference” may proceed. Conference will be scheduled by the Owner. After the conference, copies of a memo certifying that the “Instruction in Operation Conference” and “Completed Demonstration” have been made will be signed by Owner and the instructors, and one copy will be inserted in each Technical Information Brochure.

1.18 STRUCTURAL CALCULATIONS FOR ROOF-MOUNTED EQUIPMENT
A. All roof-mounted devices, equipment and systems shall be constructed, designed and fastened to withstand wind loads of velocities up to 155 mph. Structural calculations for roof-mounted equipment shall be completed in accordance with International Building Code requirements and submitted by a structural engineer registered in the State of Texas.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Specified Products: Manufacturer’s names and product model numbers indicated on the drawings and in these specifications establish the type, style, quality, performance, and sound rating of the desired product. Listing of other manufacturers indicates that their equivalent products would be acceptable if they meet the specification requirements, the specific use and installation shown on the drawings, including space and clearance requirements, and the energy consumption and efficiency of the specified product. The listing of additional manufacturers in no way indicates that the manufacturer can provide an acceptable product.

B. Space Requirements: All manufactured products furnished on this project must have the required space and service areas indicated in the manufacturer's printed literature or shown on their shop drawing. When the manufacturer does not indicate the space required for servicing the equipment, the space shown on the drawings or as required by the Architect must be provided.

2.02 MATERIAL AND EQUIPMENT
A. General: Material and equipment used shall be produced by manufacturers regularly engaged in the production of similar items, and with a history of satisfactory use as judged by the Architect.

B. Specified Equipment: Equipment shall be the capacity and types indicated or shall be equivalent in the opinion of the Architect. Material and equipment furnished and installed shall be new, recently manufactured, of standard first grade quality and designed for the specific purpose. Equipment and material furnished shall be the manufacturer's standard item of production unless specified or required to be modified to suit job conditions. Sizes, material, finish, dimensions and the capacities for the specified application shall be published in catalogs for national distribution. Ratings and capacities shall be certified by a recognized rating bureau. Products shall be complete with accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.

C. Compatibility: Material and equipment of one and the same kind, type or classification and used for identical or similar purposes shall be made by the same manufacturer. Where more than one choice is available, select the options which are compatible with other products already selected. Compatibility is a basic general requirement of product selection.

PART 3 - EXECUTION

3.01 WORKMANSHIP
A. General: The installation of materials and equipment shall be done in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a first-quality installation. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks. All materials and equipment shall be installed per the manufacturer’s written requirements.

B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function which conforms to applicable standards of building system construction and exhibits a degree of quality and proficiency which is judged by the Architect as equivalent or better than that ordinarily produced by qualified industry tradesmen.

C. Performance: Personnel shall not be used in the performance of the installation of material and equipment that, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship in the opinion of the Architect, shall be removed and reinstalled by qualified craftsmen at no change in the contract price.

3.02 CLEANING AND PROTECTION
A. General: Refer to Division 1.

BASIC MECHANICAL REQUIREMENTS
230010 - 8
3.03 CORRECTION OF WORK

A. General: At no additional cost to the Owner, rectify discrepancies between the actual installation and contract documents when in the opinion of the Commissioning Agent, T&B Agency or the Architect the discrepancies will affect system balance and performance.

B. Drive Changes: Include the cost of all pulley, belt, and drive changes, as well as balancing dampers, valves and fittings, and access panels to achieve proper system balance recommended by the T&B Agency.

3.04 COORDINATION AND ASSISTANCE

A. General: Provide all labor, equipment, tools and material required to operate the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all electric or pneumatic automated control devices and components. These services shall be available on each working day during the period of final testing and balancing.

B. Drawings and Specifications: Provide to the T&B Agency a complete set of project record drawings and specifications and an approved copy of all HVAC shop drawings and equipment submittals. The T&B Agency shall be informed of all changes made to the system during construction, including applicable change orders.

C. Coordination: Coordinate the work of all trades and equipment suppliers to complete the modifications recommended by the Commissioning Agent, T&B Agency and accepted by the Architect. Cut or drill holes for the insertion of air measuring devices as directed for test purposes; repair to as-new condition, inserting...
plastic caps or covers to prevent air leakage. Repair or replace insulation and re-establish the integrity of the vapor retardant.

3.05 PREPARATIONS FOR PERFORMANCE VERIFICATION
A. Verification: Prior to commencement of the balancing by the T&B Agency, the Contractor shall verify in writing:
   1. That air filters have been replaced and are in clean condition.
   2. That linkages between dampers and their actuators are secure, non-overloading and non-binding.
   3. That ductwork specialties are in their normal operating positions.
   4. That fans are operating at the correct rotation and specified RPM.
   5. That ductwork has been pressure tested and accepted.
   6. That linkages between valves and their actuators are secure, non-overloading and non-binding.
   7. That the operating safeties (thermal overloads, firestat/freezestats, smoke detectors, relief valves, etc.), are installed and fully functional.
   8. That equipment has been lubricated and can be operated without damage.
   9. That the systems are operational and complete.
  10. That no latent residual work remains to be completed.

3.06 ACCEPTANCE TESTING PROCEDURE
A. General: Each HVAC system shall be tested to confirm proper operation and function in accordance with the construction documents and control sequence of operations.
B. The enclosed checklists shall be completed for each system and signed off by the mechanical sub-contractor project representative, then verified and signed-off by the mechanical sub-contractor project supervisor and the construction manager systems engineer. All checklists shall be incorporated into the project’s close-out manuals submitted for Owner record.
C. On-site testing by the Architect and Engineer shall be performed at the discretion of the Architect/Engineer for any or all systems to confirm test results and system function.
D. The Contractor is responsible to provide adequate time in the completion of the construction to perform these system tests prior to the final inspections in the affected areas/systems.
E. The Contractor is responsible for ensuring all required system tests are conducted successfully and recording associated test data and results.
F. The Contractor is responsible for contacting the Architect and Engineer at least two weeks prior to system test availability and schedule acceptable to Architect/Engineer for on-site testing.
G. If, in the Architect's and Engineer’s opinion or the Commissioning Agents opinion, the test results indicate that the systems’ installation is not adequately complete for testing, the testing shall be re-scheduled and the Contractor shall be responsible to prepare for such re-test.
H. Prior to Owner occupancy, all system testing shall be completed and approved.
I. All Commissioning work must be complete and a Preliminary Commissioning Report must be provided to the Owner a minimum of 10 working days prior to the request for Final Inspection.
J. The Owner must provide written notice to the AHJ that they have received a copy of the Preliminary Commissioning Report.
K. A copy of the Preliminary Commissioning Report must be available on the job site for inspection by the building official upon request.

3.07 PROTECTION OF MATERIALS AND EQUIPMENT
A. Requirements: Do not store fiberglass insulation or any equipment within the building until it has been “dried in”. If dry space is unavailable and the insulation and equipment must be installed or stored before the building is “dried in” and completely enclosed, provide polyethylene film cover for protection.
B. Replacement of Damaged Stored Material and Equipment: Any material and equipment that has been wet or otherwise damaged prior to installation, in the opinion of the Architect, shall be replaced with new material regardless of the condition of the material and equipment at the time of installation.
C. Repair of Damaged Installed Material and Equipment: After installation correct or repair dents, scratches and other visible blemishes. At the direction of Architect replace or repair to "as new" condition equipment which has been damaged during construction.
D. During construction, all piping and ductwork system openings shall be capped with at least two layers of polyethylene film, fastened tightly in place with banding material or foil tape until connection of the continuation of such piping or ductwork is occurring.

3.08 ASBESTOS AND HAZARDOUS MATERIALS
A. General: Should asbestos or other hazardous material be encountered during execution of the work, or should the presence of asbestos or other hazardous material be suspected, immediately notify the Architect and suspend work in the affected area. The Owner will initiate a study to determine if asbestos or other
hazardous materials are present and will determine what action will be taken. Removal of asbestos or other hazardous materials will be done under a separate contract.

3.09 COORDINATION OF SERVICES
   A. General: Coordinate interruption of services to Owner-occupied areas in writing in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.

3.10 CLEAN-UP
   A. General: Debris and rubbish shall be disposed into approved AHJ containers.

END OF SECTION
REQUEST FOR SUBSTITUTION (Must be Submitted Prior to Bid)

Project Name: __________________________ Location: __________________________

Date of Request: __________________________

Name of Party Requesting Substitute:
____________________________________________________________________

Reason for Substitution Request:
____________________________________________________________________

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Proposed Substitute: _______________________________________________

Manufacturer and Model Number:
____________________________________________________________________

Deviations from the Specified Item: (See paragraph entitled "Deviations".)

Reason for Substitution:

Changes to Other Systems to Permit Use of Proposed Substitute:
(List changes. Submit drawings if required for clarity.)

Technical Data to Support Request for Acceptance:
(List ASTM or other standards designations, testing laboratory reports, experience records, etc.)

Other Supporting Data:
(Submit brochures, samples, drawings, etc.)

Certification: In making request for substitution, the party whose authorized signature appears below, certifies that all of the following statements are correct and are accepted without exception:

- The proposed substitution has been personally investigated and is equal or superior in all significant respects to the product specified for the specific applications required;
- The proposed substitution will be warranted under the same terms required for the specified product;
Coordination aspects necessitated by the proposed substitution will be accomplished in a complete and proper fashion by the party signing this form without any additional cost to the Owner; and

Claims against the Owner for additional costs related to the proposed substitution which subsequently become apparent after acceptance by the Architect are hereby waived.

Credit: If this substitution is acceptable the following credit shall be given to the Owner;

$__________________________

CERTIFICATION OF EQUIVALENT PERFORMANCE AND ASSUMPTION OF LIABILITY FOR EQUIVALENT PERFORMANCE

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted by: _________________________________________________

Signature: ___________________________________________ Title: __________________________

Typed Name: ___________________________________________

Company: _________________________________________________

Signature shall be by person having authority to legally bind his firm to the above terms. Failure to provide a legally binding signature will invalidate this request.
SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes general requirements for single-phase and poly-phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION
A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS
A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS
A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Energy efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.
F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
G. Temperature Rise: Match insulation rating.
H. Insulation: Class F.
I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS
A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
2.5 SINGLE-PHASE MOTORS
A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.
B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
D. Motors 1/20 HP and Smaller: Shaded-pole type.
E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 ELECTRICALLY COMMUTATED MOTORS (ECM)
A. Motor enclosures: Open type.
B. Motor Type: Motor to be a DC electric commutation type motor (ECM). AC induction type motors are not acceptable.
C. Bearings: Motors shall be permanently lubricated, heavy duty ball bearing type.
D. Voltage and Phase: Motors are to be pre-wired to the specific voltage and phase required.
E. Circuitry: Internal motor circuitry to convert AC power supplied to DC power to operate the motor.
F. Speed Control: Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10VDC signal.
G. Efficiency: Motor shall be a minimum of 85% efficient at all speeds.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION
SECTION 230517

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
1. Sleeves.
2. Sleeve-seal systems.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES
A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.
B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION
A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
1. Sleeves are not required for core-drilled holes.
C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION
   A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
   B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE
   A. Use sleeves and sleeve seals for the following piping-penetration applications:
      1. Exterior Concrete Walls above Grade:
      2. Concrete Slabs-on-Grade:
         a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
            1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
      3. Concrete Slabs above Grade:
      4. Interior Partitions:

END OF SECTION
SECTION 230518

ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Escutcheons.
      2. Floor plates.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS
   A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
   B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
   C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES
   A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
   B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
      1. Escutcheons for New Piping:
         a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
         b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
         c. Insulated Piping: One-piece, stamped-steel type.
         d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
         e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
         f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
         g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
         h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
         i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
         j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
         k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
   C. Install floor plates for piping penetrations of equipment-room floors.
   D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
      1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL
   A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION
SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Metal pipe hangers and supports.
      2. Trapeze pipe hangers.
      3. Thermal-hanger shield inserts.
      4. Fastener systems.
      5. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS
   A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive
      engineering analysis by a qualified professional engineer, using performance requirements and design
      criteria indicated.
   B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects
      of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
      1. Design supports for multiple pipes capable of supporting combined weight of supported systems,
         system contents, and test water.
      2. Design equipment supports capable of supporting combined operating weight of supported
         equipment and connected systems and components.
      3. Design seismic-restraint hangers and supports for piping and equipment.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation
      details and include calculations for the following; include Product Data for components:
      1. Trapeze pipe hangers.
      2. Equipment supports.
   C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and
      design criteria, including analysis data signed and sealed by the qualified professional engineer
      responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS
   A. Welding certificates.

1.5 QUALITY ASSURANCE
   A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M,
      "Structural Welding Code - Steel."
   B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure
      Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS
   A. Copper Pipe Hangers and Supports:
      1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
      2. Galvanized Metallic Coatings: Pregalvanized or hot dipped for insulated piping.
      4. Copper Coating: Copper Coating for un-insulated copper piping.

2.2 TRAPEZE PIPE HANGERS
   A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural
      carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
2.3 ATTACHMENT TO BUILDING SYSTEMS
A. The building is a steel framed structure. Attachment to the building structure will be by Clamp Connection to Steel Beams: B-Line, Grinnell, Superstrut, or equal, beam clamp with retaining clip style as required by load.

2.4 EQUIPMENT SUPPORTS, BRACING AND MATERIALS
A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
B. Miscellaneous Steel: Angles, channels, brackets, rods, clamps, etc., of new materials conforming to ASTM A36. Hot-dip galvanize steel parts after fabrication where used outdoors.
C. Fasteners: Bolts and nuts, except as otherwise specified, shall conform to ASTM Standard Specifications for Low Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A307. Bolts shall have heavy hexagon heads, and nuts shall be of the hexagon heavy series. Bolts, washers, nuts, anchor bolts, screws and other hardware used outdoors shall be galvanized, and galvanized nuts shall have a free running fit. Provide bolts of ample size and strength for the purpose intended. Ferrous metal components below grade shall be stainless steel.
D. Sheet Metal Screws: Plated, size 10 minimum.

2.5 MISCELLANEOUS MATERIALS
A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength/

2.6 FIREPROOFING OF WALL PENETRATIONS

2.7 FINISH
A. Provide galvanized steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
B. Hot-dip galvanized outdoors.
   1. Repair damage to galvanizing at welds, scratches, etc. using Z.R.C. (no known equal) cold galvanizing compound.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION
A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
C. Attachments to Structure:
   1. Steel Structure: Attach at beam axis.
   2. Rating: Ultimate strength at least 5 times the imposed load.
   3. Coordinate installation so that attachments to structure are made prior to fireproofing. If attachments must be made after fireproofing, then thoroughly clean area of fire proofing before welded or bolted attachments are made and replace fireproofing as necessary. Fireproofing material shall match existing.
D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
G. Install lateral bracing with pipe hangers and supports to prevent swaying.
H. Support vertical piping independent of the roof penetration.
I. Support horizontal piping independently of vertical riser piping.
J. Place a hanger within 12" of each horizontal elbow.
K. Use hangers with at least 1-1/2" vertical adjustment.
L. Install hangers to provide at least ½" space between finished covering and adjacent work.
M. Support pipe from the building structure so that there is no apparent deflection in pipe runs. Do not support from, or brace to, ducts, other pipes, conduit, or materials except building structure. Piping or equipment shall be immobile and shall not be supported or hung by wire, rope, plumber's tape, plastic ties, or blocking of any kind. Exposed or concealed piping which can be physically moved, and which is not properly supported will not be accepted, and additional support or bracing will be required.
N. Install building attachments to structural steel. Install additional attachments at concentrated loads, including changes in direction of piping.
O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
Q. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

3.2 EQUIPMENT SUPPORTS
A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 DUCT SUPPORT
A. Support duct risers as shown on the Drawings.
B. Ducts Supported From Above: Attach to structure using specified attachments. Minimum rod or bolt size is 3/8 inch.
C. Support Spacing: See Division 23 Section 233113 "Metal Ducts".
D. Double fold strap at attachment to structure.
E. Provide special supports where shown on the Drawings.

3.4 METAL FABRICATIONS
A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING
A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.
3.6  PAINTING
   A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
      1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
   B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.
   C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7  HANGER AND SUPPORT SCHEDULE
   A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
   B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
   C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
   D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
   E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
   F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
   G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
      1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 3.
   H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
      1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
      2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
      3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
      4. C-Clamps (MSS Type 23): For structural shapes.
   I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
      1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   J. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

END OF SECTION
SECTION 230548

VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following:
1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Freestanding spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Restraining braces and cables.

1.2 PERFORMANCE REQUIREMENTS
A. Wind-Restraint Loading:
1. Basic Wind Speed: 155.
2. Building Classification Category: IV
3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.3 ACTION SUBMITTALS
A. Product Data: For each product indicated.
B. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For professional engineer.
B. Welding certificates.
C. Field quality-control test reports.

1.5 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
5. Vibration Isolation.
B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.
C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. **Materials**: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. **Neoprene**: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. **Elastomeric Hangers**: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

E. **Spring Hangers**: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
   1. **Frame**: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   2. **Outside Spring Diameter**: Not less than 80 percent of the compressed height of the spring at rated load.
   3. **Minimum Additional Travel**: 50 percent of the required deflection at rated load.
   4. **Lateral Stiffness**: More than 80 percent of rated vertical stiffness.
   5. **Overload Capacity**: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. **Elastomeric Element**: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   7. **Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.**

F. **Curb Mounted Rooftop Package Air Conditioners**: The roof-top air conditioning equipment shall be mounted on a free standing steel spring isolated rectangular rail (curb) system. The isolation system shall be suitable for outdoor unprotected locations and it shall include a soft and flexible elastomer air and water seal which shall not short circuit the spring isolators. The isolation system shall not allow lateral movement greater than 5/8 inch for wind loads up to 100 miles per hour.

### PART 3 - EXECUTION

**3.1 APPLICATIONS**

A. **Multiple Pipe Supports**: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.

B. **Strength of Support Assemblies**: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and kinetic loads within specified loading limits.

**3.2 VIBRATION-CONTROL AND DEVICE INSTALLATION**

A. Comply with requirements in Division 07 Section “Roof Accessories” for installation of roof curbs, equipment supports, and roof penetrations.

B. **Equipment Connections**:
   1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

C. **Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.**

D. **Attachment to Structure**: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

**3.3 FIELD QUALITY CONTROL**

A. **Perform tests and inspections.**

B. **Tests and Inspections**:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
   4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90 percent of rated proof load of device.
   7. Measure isolator deflection.
8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
C. Remove and replace malfunctioning units and retest as specified above.
D. Prepare test and inspection reports.

3.4 ADJUSTING
A. Adjust isolators after piping system is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
C. Adjust active height of spring isolators.
D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION
SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct Labels
   5. Ceiling Labels

1.2 ACTION SUBMITTAL
A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS
A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
   2. Letter Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
B. Label Content: Include equipment's Drawing designation or unique equipment number.
C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS
A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: Yellow.
D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS
A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. Identify the content and directional flow of piping systems. Whenever
possible select manufacturers standard preprinted, color-coded, pipe markers. Pipe marker sizes and colors shall comply with ANSI/ASME A13.1.

B. For Pipe Sizes NPS 6 and Smaller, including Pipe Covering: Semi-rigid plastic wrap around pipe marker that extends 360 degrees around the pipe at each marker location. Include legend (pipe content) and arrows to indicate direction of flow. Equip pretensioned markers with an adhesive strip, 1/2-inch wide on the inside for applications on vertical locations. Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 3/4 inches high.

2.4 DUCT LABELS

A. General Requirements for Manufactured Duct Labels: Preprinted, color-coded, with lettering indicating service, and showing airflow direction. Identify the content and directional airflow of duct systems. Whenever possible select manufacturers standard preprinted, color-coded, duct markers. Duct marker sizes and colors shall comply with ANSI/ASME A13.1.


C. Background Color: White.

D. Lettering Size: At least 1-1/2 inches high.

E. Adhesive: Contact-type permanent acrylic adhesive, compatible with label and with substrate.

F. Duct Label Contents: Each label shall include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each branch selector, valve and control device.
   2. Near each branch connection, excluding short takeoffs.
   3. Where flow pattern is not obvious, mark each pipe at branch.
   4. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   5. At access doors, manholes, and similar access points that permit view of concealed piping.
   6. Near major equipment items and other points of origination and termination.
   7. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Pipe Label Color Schedule:
   1. Refrigerant Piping:
      b. Letter Color: Black.
   2. Natural Gas Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.
   3. Air Conditioning Condensate Piping:
      b. Letter Color: Green.

3.4 DUCT LABEL INSTALLATION

A. Locate duct labels where ductwork is exposed or above accessible ceilings in finished spaces; plenums; and exterior exposed locations as follows:
1. Locate labels near points where ducts enter into concealed spaces.
2. At maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.
3. Near each branch connection, excluding short takeoffs.
4. Where flow pattern is not obvious, mark each pipe at branch.
5. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
6. At access doors and similar access points that permit view of concealed ductwork.
7. Near major equipment items and other points of origination and termination.
8. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

B. Duct Label Color Schedule:
   1. Supply Duct
      b. Letter Color: Yellow.
   2. Return Duct
      b. Letter Color: Red.
   3. Exhaust/Relief Duct
      b. Letter Color: Green.
   4. Outdoor Air Duct
      b. Letter Color: Blue.

END OF SECTION
SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.

1.2 DEFINITIONS
C. TAB: Testing, adjusting, and balancing.
D. TABB: Testing, Adjusting, and Balancing Bureau.
E.TAB Specialist: An entity engaged to perform TAB Work.

1.3 INFORMATIONAL SUBMITTALS
B. Certified TAB reports.

1.4 QUALITY ASSURANCE
A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
B. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."
G. 2015 IECC paragraph C408.2.2 and supporting sub paragraphs.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
B. Examine systems for installed balancing devices, such as test ports, gage cocks, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
C. Examine the approved submittals for HVAC systems and equipment.
D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
E. Examine ceiling plenums used for return, air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
F. Examine equipment performance data including fan curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate
system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine operating safety interlocks and controls on HVAC equipment.

K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:
   1. Permanent electrical-power wiring is complete.
   2. Automatic temperature-control systems are operational.
   3. Equipment and duct access doors are securely closed.
   4. Balance, smoke, and fire dampers are open.
   5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
   1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP)

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
   2. Measure fan static pressures as follows to determine actual static pressure:
a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Report the cleanliness status of filters and the time static pressures are measured.
4. Measure static pressures entering and leaving other devices, such as sound traps, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within +/- 10% of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS
A. Pressure-Independent, Single Zone Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the diffuser that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal diffuser is not less than the sum of the manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome diffuser discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow. (+/- 10% of air flows indicated)
4. Set diffusers at maximum airflow and adjust the air handling unit to deliver the designed maximum airflow. When total airflow is correct, balance the air outlets the same as described for constant-volume air systems.
5. Set the air handling unit at minimum airflow and adjust to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Record final fan-performance data.

B. Motors: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

C. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.7 PROCEDURES FOR CONDENSING UNITS
A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS AND HEAT EXCHANGERS
A. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Voltage and amperage input of each phase at full load and at each incremental stage.
   5. Calculated kilowatt at full load.
   6. Fuse or circuit-breaker rating for overload protection.

B. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

C. Measure, adjust, and record the following data for each gas fired heat exchanger:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Inlet gas pressure.
   6. Flue pipe temperature.

3.9 TOLERANCES
A. Set HVAC system's air flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.

3.10 REPORTING
A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT
A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Gas flow rates
3. Duct, outlet, and inlet sizes.
4. Pipe sizes and locations.
5. Balancing stations.

END OF SECTION
SECTION 230713

DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes insulating the following duct services:
      1. Indoor, concealed supply and return air.
   B. Related Sections:
      1. Division 23 Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
      1. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
      2. Detail application of field-applied fabric and mastic at seams and joins.
      3. Detail application at linkages of control devices.

1.3 QUALITY ASSURANCE
   A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
      1. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS
   A. Comply with requirements in "Duct Insulation Schedule, General," for where insulating materials shall be applied.
   B. Insulation joints and seams shall be sealed with fabric and mastic. Tape is not approved.
   C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
   D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
      1. Products: Subject to compliance with requirements, provide one of the following:
         a. CertainTeed Corp.; SoftTouch Duct Wrap.
         b. Johns Manville; Microlite.
         c. Knauf Insulation; Friendly Feel Duct Wrap.
         d. Manson Insulation Inc.; Alley Wrap.
         e. Owens Corning; SOFTR All-Service Duct Wrap.

2.2 ADHESIVES
   A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
   B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
      1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
         b. Eagle Bridges - Marathon Industries; 225.
         d. Mon-Eco Industries, Inc.; 22-25.
      2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
C. **FSK Jacket Adhesive**: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

### 2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. **Vapor-Barrier Mastic**: Water based; suitable for indoor use on below ambient services.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.

C. **Breather Mastic**: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Eagle Bridges - Marathon Industries; 550.
      e. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.

### 2.4 SEALANTS

A. **FSK Sealants**: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   2. Eagle Bridges - Marathon Industries; 405.
   5. 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.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

2.5 FACTORY-APPLIED JACKETS
A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   2. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH
A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in.in a Leno weave, for ducts.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Vimasco Corporation; Elastafab 894.

2.7 SECUREMENTS
A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with closed seal.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

B. Insulation Pins and Hangers:
   1. 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: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
         1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
         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: Aluminum, 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.

2. 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: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
      3) <Insert manufacturer's name; product name or designation>.
   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.
3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2) GEMCO; Peel & Press.
      3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel or Aluminum or Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum 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: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      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.

5. 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 (38 mm) in diameter.
   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) GEMCO.
      2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy.
   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:

PART 3 - EXECUTION

3.1 PREPARATION
   A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS
   A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
   B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
   C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
   D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
   E. Install multiple layers of insulation with longitudinal and end seams staggered.
   F. Keep insulation materials dry during application and finishing.
   G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
   H. Install insulation with least number of joints practical.
   I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
      1. Install insulation continuously through hangers and around anchor attachments.
      2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. Apply vapor-barrier mastic over staples.
4. Cover joints and seams with fabric and mastic, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and apply fabric and mastic to seal patches similar to butt joints.

3.3 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 Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations.Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.4 INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 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 from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.6 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and return air.

B. Items Not Insulated:
   1. Factory-insulated flexible ducts.
   2. Factory-insulated plenums and casings.
   3. Flexible connectors.
   5. Factory-insulated access panels and doors.
   6. Exhaust ducts

3.7 INDOOR DUCT INSULATION SCHEDULE

A. Concealed, Supply-Air Duct Insulation: Mineral-fiber blanket, 2 inches thick and 1.5-lb/cu. ft. nominal density, maximum 0.28K-factor @75 deg F. mean temperature with factory applied FSK facing and fabric and mastic sealants at the seams and joints.

B. Concealed, Return-Air Duct Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density, maximum 0.28K-factor @75 deg F. mean temperature with factory applied FSK facing and fabric and mastic sealants at the seams and joints.

C. Exposed, Supply-Air Duct Insulation: Internally lined Mineral-fiber board, 2 inches thick and 1.5-lb/cu. ft. nominal density, maximum 0.28K-factor @75 deg F. mean temperature with factory applied FSK facing and fabric and mastic sealants at the seams and joints.

D. Exposed, Return-Air Duct Insulation: Interior Lined Mineral-fiber board, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density, maximum 0.28K-factor @75 deg F. mean temperature with factory applied FSK facing and fabric and mastic sealants at the seams and joints.

END OF SECTION
SECTION 230719
HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes insulating the following HVAC piping systems:
      1. Refrigerant suction piping, indoors and outdoors.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Drawings: Include plans, elevations, sections, details, and attachments to other work.
      1. Detail application of protective saddles, and inserts at hangers for each type of insulation and hanger.
      2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
      3. Detail application of field-applied jackets.

1.3 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.4 QUALITY ASSURANCE
   A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
      1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
      2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS
   A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
   B. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
      1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
         a. Aeroflex USA, Inc.; Aerocel.
         b. Armacell LLC; AP Armaflex.
         c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.2 ADHESIVES
   A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
   B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
      1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
         a. Aeroflex USA, Inc.; Aeroseal.
         b. Armacell LLC; AP Armaflex Adhesive.
         d. K-Flex USA; R-373 Contact Adhesive.
      2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
2.3 FIELD-APPLIED JACKETS
A. Apply two coats of the manufacturers recommended coating for outdoor insulation.

PART 3 - EXECUTION

3.1 PREPARATION
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, and thicknesses required for each item of pipe system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
F. Keep insulation materials dry during application and finishing.
G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
H. Install insulation with least number of joints practical.
I. Seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
M. Repair damaged insulation by removing the damaged insulation and applying joint sealant and insulation by applying damaged areas. Adhere and seal patches similar to butt joints.

3.3 PENETRATIONS
A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.4 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION
A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
B. Insulation Installation on Pipe 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.
C. 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.

3.5 FINISHES
A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.6 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 PIPING INSULATION SCHEDULE, GENERAL
A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Refrigerant liquid and hot gas lines.

3.8 INDOOR PIPING INSULATION SCHEDULE
A. Refrigerant Suction: Flexible elastomeric, 1.5 inches thick.

3.9 INDOOR PIPING EXPOSED PIPING INSULATION SCHEDULE
A. Refrigerant Suction: Flexible elastomeric, 1.5 inches thick with PVC cover matching ceiling color.

END OF SECTION
SECTION 230800

COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
B. Related Sections: Refer to Division 01 Section 019114 “General Commissioning Requirements for additional commissioning scope and requirements. All testing and commissioning requirements of that section shall be met.
C. The Commissioning Team will include representatives of the Owner, Design A/E, General Contractor and Installing Subcontractors, Test and Balance Subcontractor, BAS Subcontractor and Commissioning Authority (CxA).
D. Scope of Mechanical and HVAC equipment and systems commissioning
   1. All HVAC systems, including chillers, cooling towers, pumps, air handling units, terminal units, make-up air units, fan coil units, exhaust fans, computer room units, unit heaters, heat pumps, and associate equipment.
   2. All building automation system controls, associated control terminal devices, and related controls and sensors, controls and components, energy recovery devices and systems and controls.
   3. All other HVAC and mechanical system components indicated on the drawings and/or in the commissioning plan

1.2 CONTRACTOR'S RESPONSIBILITIES
A. Attend the Commissioning Kick-off meeting and other Commissioning meetings as required.
B. Attend construction phase coordination meetings.
C. Attend testing, adjusting, and balancing review and coordination meetings.
D. Complete Pre-Functional Checklists (PFCs) for all systems and equipment to be commissioned. Sign and submit the PFC’s using the submittal process for tracking. The checklists should be completed and signed by the technician performing the work. Sampling is not permitted; 100% of all equipment shall be tested.
E. Submit completed manufacturer’s start-up checklists for the equipment being commissioned. Manufacturer’s start-up documents shall be provided in addition to the completed and signed Pre-Functional Checklists.
F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period. Provide meters, gauges and instruments for Functional Performance Testing.
G. Perform all commissioning tests at the direction of the CxA.
H. Complete tasks required to correct items noted by the CxA in the Deficiency Log.
I. Participate in systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
J. Provide O&M data including warranties, tables, recommended maintenance schedules, checklists, spare parts lists, wiring and parts diagrams, points of contact for service, for all equipment, systems and controls being commissioned.
K. Provide information requested by the CxA for final commissioning documentation.

1.3 CxA's RESPONSIBILITIES
A. Provide Project-specific construction checklists and commissioning process test procedures for actual Electrical systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
B. Provide a Commissioning Plan.
C. Provide Pre-Functional Checklists.
D. Provide Functional Performance Checklists.
E. Direct commissioning testing.
F. Maintain and distribute the deficiency logs.
G. Provide a Preliminary Commissioning Report to the Owner a minimum of 10 days prior to Final Inspection. The General Contractor will ensure that a copy of the draft report is available on site for review by the building official. The preliminary report shall include the following as a minimum:
   • Results of the mechanical and service water heating testing in separate sections for independent review.
• Itemized deficiencies found during testing that have not yet been corrected at the time the report is issued.
• Tests that cannot be completed at the time of report preparation, and reasons that the testing could not be completed.

H. Review the O&M documents for clarity and completeness.

I. Review the O&M Manual that is prepared by the General Contractor and provided to the Owner and which includes the following:
• Submittal data stating selected size and options for each piece of equipment.
• Name and address of at least one qualified service agency.
• Service water controls system maintenance and calibration information. Include wiring diagrams, schematics, and control sequences descriptions.
• Desired or field determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in the programming instructions.

J. Provide a Final Commissioning Report. The final report shall include the following as a minimum:
• Results of the Functional Performance Tests.
• Disposition of deficiencies found during testing, including the details of corrective measures used or proposed.
• Functional performance tests procedures during the commissioning process, including measurable criteria for test acceptance, provided for repeatability.

1.4 PROCESS

A. Functional Performance Testing will commence after preliminary punch list items are completed by the Contractor. Functional Performance Testing will not be scheduled until the completed Pre-Functional Checklists and the Draft TAB Report are received by the Commissioning Authority.

1.5 SUBMITTALS

A. Certificate of Readiness indicating the HVAC systems are ready for Commissioning.
B. Completed Pre-Functional Checklists shall be provided as a submittal for tracking purposes. Pre-Functional Checklists shall be completed and signed by the technician performing the work. Sampling is not permitted for the completion of the Pre-Functional Checklists.
C. Manufacturer’s start-up checklists.
D. Flushing and pressure test reports.
E. Draft and Final Testing, Adjusting and Balancing (TAB) Reports.
F. Sixty (60) days before any mechanical systems testing is conducted, provide an overall testing plan and schedule for HVAC equipment and BAS control systems that lists the equipment, modes to be tested, dates of testing and parties required to conduct the test. Put this information in to the master construction schedule. Keep the plan and schedule updated.

1.6 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA:
1. Approved submittals with designer review comments of submittals resolved, operation and maintenance manuals, and assistance in preparing the systems manuals, and other documents and reports requested by the Commissioning Authority in searchable pdf format.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase on as built markup of the design documents (plans and specifications).
3. Process and schedule for completing construction checklists and manufacturer’s prestart and startup checklists for systems, assemblies, equipment, and components being commissioned.
4. Completed PFCs certifying that installation, prestart checks, and startup procedures have been completed.
5. Schedule indicating when HVAC systems, subsystems, equipment, and associated controls will be ready for functional testing. The date for permanent connection of power is required.
6. Provide, documentation of completion of flushing and pressure test reports and certificates.
7. Corrective action documents.
9. The Contractor shall provide updated “As-Built” single line drawings for MEP systems and BAS systems. The drawings are to be provided in the electronic format requested by the CxA.
10. Any additional information requested by the CxA.
PART 2 - PRODUCTS  (Not Used)

PART 3 - EXECUTION

3.1 GENERAL
A. The Contractor shall be responsible for performing procedures presented in specification and contract drawings as detailed in the Functional Performance Tests (FPT). Members of the designated Commissioning Team shall witness various portions of the commissioning process. Commissioning Team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the Owner and CxA.
B. Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by the Contractor.
C. Contractor shall provide to the Commissioning 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 TESTING PREPARATION
A. Certify in writing the HVAC systems, subsystems, and equipment and controls have been installed, calibrated, started and are operating per the Contract Documents. Ensure the PFCs are completed and submitted by factory authorized start up tech and submitted to the Contractor.
B. Certify in writing the Testing, Adjusting, and Balancing (TAB) procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
C. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
D. Inspect and verify the position of each device and interlock identified in the sequences, control schematics and or on checklists.
E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
F. Testing Instrumentation: Install measuring instruments and logging devices to record test data if directed by the CxA in the Commissioning Plan.

3.3 TESTING AND BALANCING VERIFICATION
A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CxA.
   1. The Contractor will notify the CxA 10 days in advance of the date of Test and Balance (TAB) field verification.
   2. The same instruments (by model and serial number) that were used when original data were collected shall be used during the TAB verification with the CxA.
   3. Failure of an item includes a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
   4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.
D. TAB verification is to be conducted using the same instruments used for the conduct of the initial Testing Adjusting and Balancing of the systems.

3.4 GENERAL TESTING REQUIREMENTS
A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.
B. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
C. The Contractor shall execute the detailed testing plans, procedures, and checklists (PFCs and FPTs) prepared by the CxA for systems, subsystems, and equipment being commissioned.
D. Tests will be performed using design conditions whenever possible.
E. Simulated conditions may need to be imposed when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
F. The CxA may direct that set points be altered to achieve simulated conditions.

G. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the CxA will document the deficiency and report it to the Owner. After deficiencies are resolved, the Contractor will reschedule the tests.

H. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 INSTRUMENTATION

A. Instrumentation for Functional Performance Testing and data recording shall be provided. 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.

3.6 INSTALLATION VERIFICATION

A. Before system start-up begins, the Contractor shall conduct a final installation verification audit. The Contractor shall be responsible for completion of work including change orders and punch list items to the Owner’s satisfaction.

B. If work is found to be incomplete, incorrect, or non-functional, the Contractor shall correct the deficiency before system start-up work proceeds.

3.7 SYSTEM START-UP & PRE-FUNCTIONAL CHECKLIST

A. System start-up shall be performed by the Contractor in accordance with the manufacturer’s written startup instructions and documented with the Pre Functional Checklist (PFCs)

1. Designated members of the Commissioning Team may witness system start-up and list system and equipment deficiencies noted during start-up, however that is not required for system start-up and PFC documentation to be performed.

2. The Contractor shall take corrective action on system deficiencies found or noted and demonstrate and document proper 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.

B. Completed, signed-off PFCs shall be submitted once the system start up is complete for each system.

3.8 FUNCTIONAL PERFORMANCE TESTING

A. The objective of the Functional 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, design intent, and Owner requirements.

B. Functional Performance Testing begins after all PFCs have been completed, submitted, and reviewed by the CxA, and after Test and Balance has been completed.

C. Functional Performance tests for the systems to be commissioned are defined in the Commissioning Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.

1. Draft Functional Performance Test procedures will be provided by the CxA to the Owner, Designers and Contractors for review and comments. Comments will be reviewed and incorporated into the final Functional Performance documents.

2. Final Functional Performance Test documents will be provided for testing.

3. Functional Performance Testing will be executed by the Contractors and witnessed by the CxA.

4. The Commissioning Authority develops specific written equipment, system and assembly Functional Performance Test (FPT’s) procedures for all commissioned HVAC equipment. The following functions as a minimum will be tested:

   - All modes as described in the sequences of operation.
   - Redundant or automatic back-up modes.
   - Performance of alarms.
   - Mode of operation upon a loss of power and restoration of power.
   - All economizers shall be functionally tested.
   - Additional items included in the Functional Performance Test documents provided by the CxA.
5. Pipe system purging, pressure and vacuum tests, and similar requirements are specified in Division 23 Sections. Perform pipe system cleaning, flushing, and hydrostatic testing. Provide cleaning, flushing, testing, and treating completion confirmation and final reports to the CxA.

6. Provide technicians, instrumentation, tools, and equipment to test performance of HVAC and BAS systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item to be tested.

7. Provide technicians, instrumentation, tools, and equipment to test performance of air, natural gas and refrigeration systems; exhaust systems; and other distribution systems, including HVAC terminal equipment and unitary equipment.

8. Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls as required in the Division Section "Testing and Balance."

3.9 NON-CONFORMANCE

A. The CxA will record the results of the Functional Performance Tests. All deficiencies, non-conformance issues, or test failures will be noted and reported to the Contractor in a deficiency list or in a punch-list format.

B. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.

C. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owners Representative.

D. Re-testing.

1. If a Functional Performance Test fails, corrections shall be made to the deficient equipment or systems by the Contractor. The systems will be re-tested until they pass the Tests.

2. The time/cost for the CxA to perform any re-testing required because of improper set up of the systems by the Contractor or failed functional or performance tests will be back-charged to the Contractor (who may choose to recover costs from the party responsible for executing faulty equipment start-up/checkout and associated checklists). This includes instances where a specific item was overlooked in the equipment start-up and checkout procedures, reported to have been successfully completed, but determined during Functional Performance testing to be faulty.

3. Any required re-testing by any Contractor or vendor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

END OF SECTION
SECTION 230900

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 DIRECT DIGITAL CONTROL (DDC) SYSTEM DESCRIPTION

A. Intent. This project consists of a new Direct Digital Control (DDC) system as required to accomplish the specified sequences of operation for control of heating, ventilating, air-conditioning and other building equipment and systems as described herein.

1.02 DDC SYSTEM REQUIREMENTS

A. BACnet®. The new DDC control system is a high-speed, peer-to-peer internetwork of ANSI/ASHRAE 135 native BACnet® DDC devices. The new controls shall incorporate input/output devices, mechanical/electrical automatic temperature control devices, enclosures, interconnecting conduit and cabling to interface with this system.

1. The BACnet® operating stack must be embedded directly in each individual DDC device at the media access controller level and in all operator interface and configuration applications.

2. Communication gateways, bridges, protocol translators or any other device that translates any proprietary communication protocol to BACnet® shall not be permitted as a part of the DDC system provided pursuant with this specification except as required to communicate to existing building systems.

B. BIC. All DDC devices shall be tested, certified, clearly stamped and listed by the BACnet® Testing Laboratories (BTL) prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

C. Modularity. The DDC system shall be modular in nature and implemented in such a manner that it can be expanded in both capacity and functionality through the addition of DDC controllers, devices and wiring.

D. Local Database. All logic required to perform the specified sequences of operation, trending and alarming as outlined in this specification shall reside in each individual DDC device. Should network communications fail, each device shall be capable of performing local control strategies without reliance upon any other device.

1. DDC devices that require any supervisory server software or hardware or any external platform to manage database execution or network management shall not be permitted as a part of the DDC system provided pursuant with this specification.

1.03 DDC SYSTEM ARCHITECTURE

A. BACnet®. The DDC system as provided and installed under this specification shall comprise a BACnet® Internetwork. All communication shall conform to ANSI/ASHRAE Standard 135, BACnet®.

B. Consistency. The DDC system as provided and installed under this specification shall be a complete system from a single manufacturer designed for use on intranets and the Internet.

C. FLCN. Field Level Communication Networks (FLCNs) shall be comprised of BACnet® networks of unitary BACnet® controllers and devices using the BACnet® data link Master Slave/Token Passing (MS/TP).

D. BLCN. Building Level Communication Networks (BLCNs) shall be comprised of a BACnet®/IP Local Area Network (LAN) for the interconnection of FLCNs, BACnet® devices and operator interfaces using the BACnet® data links BACnet®/IP (B/IP) or BACnet®/Ethernet (ISO 8802.3).

E. ELCN. An Enterprise Level Communication Network (ELCN) shall be comprised of a BACnet®/IP Wide Area Network (WAN) for the interconnection of BLCNs and high level operator interface (HLI) using the BACnet® data link BACnet®/IP (B/IP).

F. Internetwork. Internetwork operator interface and BACnet® communication shall be transparent to network architecture.

1. BACnet® communication shall be automatically routed to all configured BACnet® networks by DDC control devices on the internetwork. Dedicated, stand-alone BACnet® routers and/or routing devices shall not be necessary or accepted.

INSTRUMENTATION AND CONTROLS FOR HVAC

230900 - 1
1.04 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION
A. Provide, supervise and coordinate the installation of components supplied under this Section but installed under other divisions of the specification
B. Gas meters are to be installed by the contractor responsible for the installation of the applicable piping system.
C. Automatic control dampers, airflow measuring stations, and duct-mounted airstream sensors and devices to be installed by the contractor responsible for the installation of the applicable associated duct and/or mechanical system.
D. Electrical power and energy meters shall be installed by the contractor responsible for the installation of the electrical power system.

1.05 RELATED SECTIONS
A. The General Conditions of the Contract, the Supplementary Conditions and General Requirements of the project are part of this specification and shall be used in conjunction with this section as part of the Contract Documents.
B. Heating, Ventilating and Air Conditioning Specification
C. Electrical System Specification

1.06 QUALITY ASSURANCE
A. DDC System Manufacturer shall be engaged full-time in the manufacture of equipment and devices of the scope, size and service required.
C. The DDC system Contractor shall specialize and have a minimum of five (5) years of experience in the design, installation, programming and operation of the existing Siemens DDC system and for the new equipment provided as well for the scope, size and service specified; and shall:
   1. Be an officially authorized representative of the DDC System Manufacturer with an established relationship of not less than three (3) years.
   2. Assign to the project technicians and engineers who are officially trained and certified by the DDC System Manufacturer in the design, installation, programming and operation of the DDC System components.
D. The DDC BACnet® Internetwork shall be based upon and installed according to the DDC System Manufacturer’s standard integrated hardware and software product design and in accordance with the Manufacturer’s installation and application documentation and must interface with the existing Siemens DDC control system.

1.07 CODES AND STANDARDS
A. Workmanship, materials and equipment together with the resultant complete and operational DDC System shall be in compliance with the Authorities Having Jurisdiction (AHJ) for the project and the most restrictive of applicable local, state and federal codes and ordinances in cooperation with these plans and specifications. At a minimum, the installation shall comply with the applicable sections of the current editions in effect thirty (30) days prior to receipt of bids of the following codes:
   1. ANSI/ASHRAE Standard 135: BACnet® - A Data Communication Protocol for Building Automation and Control Networks
   4. International Mechanical Code (IMC) 2015
   5. Underwriters Laboratories (UL)
      a. UL-916 – Energy Management Systems (EMS)
      b. UL-864/UUKL – Control Units and Accessories for Fire Alarm Systems

1.08 SYSTEM PERFORMANCE
A. Graphic Display. A minimum of 50 dynamic real-time data points within 10 seconds of the request and shall refresh with current data within 5 seconds.
B. Operator Command. The maximum time between the command of a binary or analog object by the operator and the reaction initialization by the device shall be 5 seconds.

C. Object Command. Devices shall respond to automatic command of a binary or analog object within 2 seconds.

D. Object scan. Changes of state or analog shall be transmitted such that no reporting of a value is more than 15 seconds old.

E. Alarm Response. The maximum amount of time from when an object goes into alarm until it is annunciated shall not exceed 20 seconds.

F. Program Execution. All programs in all DDC devices shall be able to execute at a minimum of at least one time every second. Program execution time shall be configurable to be consistent with the process under control.

G. Control Loop Performance. All DDC devices shall be able to execute control loops at a frequency at least one time every second. The controller shall update the process value and output generated by this calculation at this same frequency at a minimum.

H. Environmental Conditions. All DDC System components provided under this specification shall operate under ambient environmental conditions of -20°C (-4°F) to 55°C (131°F) dry-bulb and 10% to 90% relative humidity, non-condensing as a minimum. Sensors and control elements shall be constructed of material suitable and rated for the media sensed under the ambient environmental temperature, pressure, humidity, and vibration conditions encountered for the installed location.

I. Power Conditions. Networked components of the DDC System shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.

J. Reporting Accuracy. System shall report values with minimum end-to-end accuracy as listed in Table 1.

K. Control Stability and Accuracy. Control applications shall maintain process variables at setpoint within the tolerances listed in Table 2.

1. Combined system repeatability of sensors, controllers and readout devices for a particular application shall be plus or minus 2% of full scale of the operating range.

2. Repeatability of overall combined system of sensor, controller and readout device in a control loop application will be plus or minus 5% of full scale of the operating range.

3. Long-term electronic drift shall not exceed 0.4% per year.

### TABLE 1: REPORTING ACCURACY

<table>
<thead>
<tr>
<th>PROCESS VARIABLE</th>
<th>REPORTING ACCURACY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Temperature</td>
<td>±0.5°C (±1.0°F)</td>
</tr>
<tr>
<td>Ducted Air Temperature</td>
<td>±1.0°C (±2.0°F)</td>
</tr>
<tr>
<td>Outdoor Air Temperature</td>
<td>±1.0°C (±2.0°F)</td>
</tr>
<tr>
<td>Delta-T</td>
<td>±0.15°C (±0.25°F)</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>±2% RH</td>
</tr>
<tr>
<td>Air flow (measuring stations)</td>
<td>±2% of full scale</td>
</tr>
<tr>
<td>Air flow (pressurized spaces)</td>
<td>±3% of full scale</td>
</tr>
<tr>
<td>Air pressure (ducts)</td>
<td>±25 Pa (±0.1 in. WG)</td>
</tr>
<tr>
<td>Air pressure (space)</td>
<td>±3 Pa (±0.01 in. WG)</td>
</tr>
<tr>
<td>Electrical Power (A, W, V &amp; PF)</td>
<td>±2% of reading (Note 3)</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>±50 PPM</td>
</tr>
</tbody>
</table>

**NOTE 1:** Accuracy applies to 10%-100% of scale

**NOTE 2:** For both Absolute and Differential pressure

**NOTE 3:** Not including utility-provided meters

### TABLE 2: CONTROL STABILITY & ACCURACY

<table>
<thead>
<tr>
<th>PROCESS VARIABLE</th>
<th>CONTROL ACCURACY</th>
<th>RANGE OF MEDIUM</th>
</tr>
</thead>
</table>

INSTRUMENTATION AND CONTROLS FOR HVAC

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### Air Pressure

<table>
<thead>
<tr>
<th></th>
<th>±50 Pa (±0.2 in. WG)</th>
<th>±3 Pa (±0.01 in. WG)</th>
<th>0-1.5 kPa (0-6 in. WG)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>±0.2 in. WG</td>
<td>±0.01 in. WG</td>
<td>0-6 in. WG</td>
</tr>
<tr>
<td></td>
<td>-25-25 Pa (-0.1-0.1 In. WG)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Air flow

±10% of full scale

### Space Temperature

±1.0°C (±2.0°F)

### Duct Temperature

±1.5°C (±3.0°F)

### Humidity

±5% RH

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**1.09 SUBMITTALS**

A. Submit in compliance with all General Conditions of the Contract, Supplementary Conditions and General Requirements of the project and in conjunction with the requirements of this section.

B. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.

C. All submittals and documentation including complete DDC System engineering design submittal & drawings, project record documents, application engineering documents and owner’s & maintenance manuals shall be submitted electronically in the form of an ISO 32000 Portable Document Format (PDF). All control schematics, wiring diagrams, riser diagrams, etc. shall be formatted for A3 paper size (297mm x 420mm, 11" x 17"). All other documentation may be formatted for A4 (210mm x 297mm, 8.5” x 11’’). Submittal format shall be per 2015 IECC paragraph C408.2.5.2 “Manuals”.

D. Submit in writing and so delineated at the beginning of each submittal, known conflicts, substitutions and deviations from requirements of Contract Documents. Deviation from Contract Documents must be approved by Owner and/or contracting officer prior to award of contract.

E. Each submitted piece of literature and drawing shall clearly reference the applicable specification section and/or drawing that the submittal responds to. General catalogue sheets shall not be acceptable as cut sheets.

F. Submittal documentation and drawings shall consistently use the same abbreviations, symbols, nomenclature and identifiers. Each control system element shall be assigned a unique identifier pursuant with the Contract Documents.

G. Submittal documentation and drawings shall have at the beginning an index and design drawing legend.
   1. Index shall list all design drawings and elements including the drawing number, sheet number, drawing title, etc.
   2. Legend shall show and describe all symbols, abbreviations and acronyms used on the design drawings.

H. DDC System Hardware Submittals
   1. A complete bill of materials of all equipment, controllers, devices and sensors to be provided and/or used indicating unique equipment identifier, unique device identifier, manufacturer, model number and quantity.
   2. A Protocol Implementation Conformance Statement (PICS) including a BACnet® Interoperability Building Block (BIBB) table for each DDC device included in the submittal.
   3. Manufacturer’s technical data including product specification sheets, performance curves and installation/maintenance instructions. When manufacturer’s cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly called out by other means.
   4. Schematic diagrams for all field sensors and controllers providing floor plans indicating the locations of all sensors, devices and temperature control panels.
   5. Control enclosure details for each enclosure including panel identifier, location, physical layout, dimensions, instrumentation, labels, etc.
   6. Wiring diagrams and schematics for each control enclosure showing and power source for each panel, secondary power and network termination as well as all individual terminations, terminal numbers, point type and mnemonic/name.
   7. Wiring diagrams for all packaged equipment, motor starters, relay wiring, equipment interlock, safety circuits, etc. clearly indicating all interconnecting wiring and termination of all conductors and cables including labels of all cables and point mnemonics.
   8. Wiring diagrams and schematics for each sensor.

I. Controlled System Submittals

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**INSTRUMENTATION AND CONTROLS FOR HVAC**

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1. Riser diagram showing the physical lay-out of the entire Internetwork.
2. Riser diagram for each individual BACnet® network including the ELCN, and each BLCN and FLCN including:
   a. Data link with physical characteristics and configuration.
   b. Each BACnet® networked DDC device including location, service, device instance, MAC address and network number.
   c. Each IP networking device including location, service and IP address.
   d. Location of all interface devices including network interface jacks connections.
   e. Location of all MS/TP network termination points and End-of-Line terminations.
3. A schematic control flow diagram of each controlled system showing actual physical configuration and location of all control elements including each hardware point type, controller and mnemonic.
4. A schematic wiring diagram of each controlled system showing actual physical wiring and termination of all control elements including each hardware point type, controller, mnemonic and terminal number.
5. An instrumentation list for each controlled system displaying each control element, name, manufacturer, model and product data sheet number in a tabular format.
6. A complete description of the operation of the DDC System including a specific Sequence of Operation for each controlled system. Sequences of operation shall:
   a. Reference the submitted schematic of the controlled system.
   b. Refer to equipment and control devices by their specific unique identifiers pursuant with the Contract Documents and the DDC System submittal package.
   c. Clearly represent actual application programming methodology and functional control operation not merely a copy of the Contract Document specified sequence of control.
   d. Include a concise description of functional system operation under specified normal and failure conditions.
   e. Include a complete hardware input and output (I/O) points schedule identifying for each point its instance, type, name/mnemonic, controller, equipment/function, location, termination, and override, alarm and display criteria.
7. Operational deviation from the specified Sequences of Operation as outlined in Contract Documents shall not be permitted under any circumstances without prior written approval.
8. A schedule of all control valves including the unique equipment identifier, valve size, dimensions and installation/maintenance clearance, model number (including pattern and connections), close-off rating, flow, CV, pressure drop, pressure rating and location. The valve schedule shall also contain actuator selection data supported by calculations of the force required to move, close and seal the valve at design conditions.
9. A schedule of all control dampers. This shall include the unique equipment identifier, unique damper identifier, damper size, pressure drop, blade configuration, orientation and axis of frame, blade rotation, location and selection criteria of actuators, nominal and actual sizes, and manufacturer and model number. The Damper Schedule shall include the AMCA 500-D maximum leakage rate at the operating static-pressure differential.

J. Schedules
1. Provide a schedule of work indicating at a minimum the intended sequence of work, start dates and durations for individual activities, delivery dates for major materials and equipment including anticipated lead times and milestones indicating possible restraints on work by other trades or construction delays.

K. Project Record Documentation
1. Upon completion of installation and systems commissioning submit record (as-built) documents for review to include:
   a. Testing and commissioning reports and checklists
   b. Operation and Maintenance (O&M) manual
   c. As-built revisions of all submittal data updated to reflect actual field conditions, architecture and execution.
   d. Names and 24-hour contact information for installing contractors and service representatives.
e. Operator’s manual with administrator and operator level credentials and procedures for operating the DDC System including logging-on/off, handling alarms, generating points reports, trending data, overriding automatic control, changing setpoints and control variables.

f. Programming manual describing the programming language structure and syntax.

g. Engineering manual describing database management and modification.

h. Installation and maintenance manuals describing how to install and configure new hardware as well as how to perform routine preventative maintenance and calibration together with corrective diagnostic troubleshooting procedures.

i. Documentation of all programs created including setpoints, tuning parameters and final database.

j. Complete system database as functional at the conclusion of systems commissioning and functional testing including all graphics and images used by and/or created for DDC System on electronic format as accepted by Owner.

k. Final Bill of Material with all installed parts, manufacturers, manufacturers’ part numbers and ordering information.

l. A schedule of recommended spare parts with part numbers and supplier.

m. All original-issue installation and maintenance manuals, user guides, and other documentation provided with all hardware and software provided as a part of this specification.

n. Licenses, guarantees and warrantee documentation for all equipment and systems.

L. Submittal format should be per 2015 IECC paragraph C408.2.5.2 and supporting sub paragraphs.

M. Training

1. Provide training course outline and curricula to the CxA, owner and engineer at least six (6) weeks prior to training. CxA, Engineer and/or Owner shall review and modify the curricula as necessary to meet the Owner’s Project Requirements (OPR). Revised curricula shall be returned no later than three (3) weeks prior to the training.

1.10 WARRANTY

A. The DDC System Manufacturer shall warranty all DDC controllers to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit’s performance specifications for a minimum period of five (5) years from the date of substantial completion.

1. Sensors and field components integral to DDC controllers shall be warrantied to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit’s performance specifications for a minimum period of one (1) years from the date of substantial completion.

B. The DDC System Contractor shall warranty the installation of all other DDC materials and labor to be free of defects under normal expected service and use for a minimum period of one (1) year from the date of substantial completion.

C. DDC System failures during the installation warranty period shall be adjusted, repaired or replaced at no additional cost or reduction in service to the Owner. Except in the event of property loss or damage, warranty service shall be provided during regular working hours Monday through Friday.

1.11 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project specific software and documentation shall become the owner’s property including but not limited to graphics, record drawings, database, application programming code and documentation upon project acceptance.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. All DDC devices shall be tested, certified, clearly stamped and listed by the BACnet® Testing Laboratories (BTL) prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).
B. The order of manufacturers does not indicate preference. Inclusion on this list does not guarantee acceptance of products or installation. DDC Systems shall comply with all of the requirements of this specification.

C. The following are approved DDC System manufacturers and product lines:
   1. Siemens Building Technologies, Inc.

D. All DDC System networked devices specified herein including controllers and routers shall be provided by one of the manufacturers listed above.
   1. OEM and/or private-labelled controllers or software manufactured or developed by a third-party and labelled or otherwise represented as being a product of one of the allowable manufacturers listed above shall not be accepted under this specification.

E. Other non-networked system components specified herein (including sensors, valves, dampers, etc.) need not be manufactured by the above manufacturers.

F. The DDC System Manufacturer product line selected shall be the most current and complete offering from the manufacturer and shall currently be actively manufactured and supported at the time that this project is bid.

G. This project shall not be used as a test site. First release and test version hardware, software and firmware shall not be implemented on this project under any circumstances.

H. DDC System devices and spare components or equivalent shall be readily available for a minimum of five (5) years after the completion and final acceptance of this project.

I. Control system shall include the following:
   1. Building lighting control system specified in Section 260923 "Addressable-Fixture Lighting Controls".
   2. Interface to the Fire alarm system specified in Section 283111 "Digital, Addressable Fire-Alarm System".

2.02 COMMUNICATION

A. The DDC system as provided and installed under this specification shall comprise a BACnet® Internetwork. All communication shall conform to ANSI/ASHRAE Standard 135, BACnet®.

B. The DDC system shall be modular in nature and implemented in such a manner that it can be expanded in both capacity and functionality through the addition of DDC controllers, devices and wiring. Expansion shall not require operator interface or configuration hardware additions, software revisions or hardware, operating system/feature licensing.

C. All DDC System BACnet® networked devices with Real-Time Clocks (RTCs) shall utilize the BACnet® Time Synchronization service. The System shall automatically synchronize system clocks from a designated Time Master periodically via the Internetwork. The System shall also automatically adjust for configurable Daylight Savings Time and Standard Time as applicable.

2.03 CONTROLLERS

A. BACnet® Compliance. All DDC controllers shall be tested, certified, clearly stamped and listed by the BACnet® Testing Laboratories (BTL) prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

B. Specification Compliance. All DDC controllers shall comply with the general requirements of all parts of this specification.

C. Application. Each individual mechanical system or piece of equipment shall be controlled by no more than one (1) dedicated controller with sufficient hardware and database capacity such that it shall be connected to all field devices and sensors associated with that system and/or piece of equipment.
   1. Distributed control of one (1) single piece of mechanical equipment shall not be performed by multiple controllers.

D. Memory. Each controller shall have sufficient memory to support its operating system, database, and programming requirements. Battery/capacitor shall maintain programming and clock memory and functions for a minimum of 72 hours.
   1. Each controller shall provide microprocessor based self-contained stand-alone fully programmable operation of local process control loops. All local level application programs shall be installed on individual controllers in non-volatile memory.
E. Updates. All controllers shall permit simple operating system firmware updates at any time after installation, utilizing the BACnet® network. Operating system firmware that requires chip replacement or flash modification will not be acceptable.

F. Data Sharing. Each controller shall be capable of locally executing global strategies for the DDC System based on information from any object in the internetwork. Control systems that require a higher-level host processor for update, time stamps, global point data, COS transfer, on-line control instruction, or communications control between panels shall not be acceptable.

G. Serviceability. Each DDC controller shall be provided with diagnostic LEDs for power, communication and processor. All wiring connections shall be made to field-removable, modular terminal strips.

H. Universal Inputs. All hardware inputs on all controllers shall be of the universal type and shall support the following physical characteristics at a minimum:
   1. Dry-contact
   2. Pulse/Pulse-width accumulation
   3. Resistance
   4. Voltage
   5. Current
   6. 24 VAC over-voltage protection

I. Universal Outputs. All controllers with universal type hardware outputs and shall support the following physical characteristics at a minimum:
   1. Contact closure
   2. Analog/Modulating
   3. 24 VAC over-voltage and short protection

J. Operator Override. All BACnet® Building Controllers (B-BC) shall support operator-initiated timed overrides of hardware and software objects with user-configurable override periods. When the override period has expired, the controller shall automatically return the object to the automatic state without any additional action on the part of the Operator.
   1. The timed override functionality shall exist entirely in the controller. A workstation shall not be required for the execution of the time period nor for returning the object to automatic.

K. Database. Programming, configuration and modification shall be accomplished via the Internetwork from the B-AWS. The complete operational database and application program shall reside in each individual controller.
   1. All controllers delivered as a part of this specification shall be configured using one (1) common B-AWS. Devices that require custom applications for configuration shall not be acceptable.
   2. The controllers shall function in a real-time, multi-tasking networked operating environment; able to display database values, programs, and control loops in real-time while functional and online using the B-AWS. The user shall be able to add, delete, or modify objects on-line as required without taking the controller offline. The programming shall provide all the necessary mathematics, logic, utility and control functions necessary to execute the specified sequence of control.

L. Programmability. All controllers shall be freely-programmable and support custom control strategies, programs and databases that are completely modifiable over the BACnet® Internetwork once installed.
   1. All controllers delivered as a part of this specification shall be programmed using one (1) common programming language, means and method via the B-AWS. Devices that require custom applications for configuration shall not be acceptable.
   2. Control systems that exclusively utilize configurable-only ‘canned’ programs or programmable read only memory (PROM) level application programming are not acceptable.

M. Alarm Processing. A controller’s ability to report alarms shall not be affected by either operator activity, execution of programs or communications with other controllers on the network.

N. Scheduling. All controllers shall support the standard BACnet® Schedule and BACnet® Calendar objects.
   1. Schedule objects shall reside in each individual device. Workstation or server-based scheduling shall not be acceptable.
2. BACnet® Schedule objects shall support binary, analog, and multi-state values.
3. Each calendar day shall support up to a minimum of ten (10) transitions.
4. BACnet® Schedule objects shall be able to directly command any BACnet® object in the internetwork without requiring custom programming.
5. Exception Schedules shall be configurable for any calendar day.
   a. Each Exception Schedule and holiday shall be individually configurable including name, priority, transition values and times.
   b. The operator shall have the ability to configure Exception Schedules to be active on specific dates, date ranges, recurring date patterns or as commanded by BACnet® Calendar objects or other override objects.

O. Trending. All BACnet® Building Controllers (B-BC) shall support both standard BACnet® Trend Log and BACnet® Trend Log Multiple objects.

P. Runtime Logs. All controllers shall support logging and reporting of runtime for every binary object in the system.
   1. Runtime data shall be sampled and stored in each individual BACnet® device using standard BACnet® objects and published properties. A workstation shall not be required for storage of custom runtime logs.
   2. Runtime data shall include at a minimum total accumulated active time, total accumulated active transitions, active transitions today, timestamp and duration for each change of state for the previous 100 transitions.

Q. Communicating Sensors. All controllers shall support and be capable of monitoring and controlling a network of communicating space sensors without consuming physical hardware input/output points on the device.

2.04 BUILDING LEVEL CONTROLLERS

A. Building Level Controllers. A dedicated building-level controller shall be provided for the execution of global strategies and for each large point-count major mechanical system and/or piece of equipment.
   1. Any application exceeding eight (8) inputs or eight (8) outputs shall be considered a building-level application and shall require a dedicated building-level controller.

B. BACnet® Device Profile. All building level controllers shall comply with the minimum requirements of ANSI/ASHRAE Standard 135 Annex L for a BACnet® Building Controllers (B-BCs) and shall be certified and listed by the BACnet® Testing Laboratories (BTL) as a B-BC prior to the bid date for this project. BTL product listings are available from BACnet® International (http://www.bacnetinternational.net/btl/).

C. BACnet® Networking. Building level controllers shall reside on the ELCN, BLCN or FLCN using the BACnet®/IP, BACnet®/Ethernet or MS/TP data links as specified in ANSI/ASHRAE Standard 135.

D. Communication. Building level controllers shall support the following communications requirements at a minimum:
   2. Client and Server BACnet® Read Property Multiple (RPM) Service.
   3. BACnet® transmit and receive frame segmentation.
   4. Post-installation, field-configurable maximum information frames, APDU frame timeout, APDU segment timeout and APDU retries.

E. Alarm Annunciation. Building level controllers shall support SMTP and provide stand-alone remote annunciation of alarms via e-mail without additional hardware, B-OWS, B-AWS or web-server.

2.05 COMMUNICATING SPACE SENSORS

A. Communicating Space Sensors. All controllers of the DDC System as provided will support networked, communicating space sensors for monitoring of internal environmental conditions and low-level operator interface without consuming hardware inputs/outputs on the host DDC controller.
   1. Communicating space sensors shall be aesthetically pleasing and specifically designed for permanent installation in a finished, occupied space. Set-point adjustment, set-point indication, and thermometer shall be concealed. Color shall be white and orientation shall be vertical.
2. All communicating space sensors shall be developed, manufactured and supported by the same manufacturer of the DDC System components specified herein and provided by the DDC System Contractor.

3. A minimum of four (4) communicating space sensors shall be supported by each DDC controller.

4. Space mounted terminal unit controllers with fewer than four (4) inputs and four (4) outputs shall not be required to support communicating space sensors.

B. System Interface. Communicating space sensors shall be capable of providing access to the Internetnetwork for a portable operator terminal.

2.06 AUTOMATIC CONTROL DAMPERS

A. Automatic Control Dampers. All automatic control dampers provided as a part of this specification shall bear the AMCA seal in compliance with the AMCA Certified Ratings Programs.

B. Opposed Blade Style. Unless otherwise scheduled on the contract drawings, opposed blade dampers shall be as follows:

1. Opposed blade dampers shall be used for all mixing, volume throttling and discrete airflow control applications installed in outdoor, relief, exhaust, and/or supply air streams as well as all applications immediately upstream of critical equipment and all ducted outlets.

2. Blade edges shall be interlocked and blade seals shall be compressible at all contact points. Channel frames shall also be provided with jamb seals.

C. Sections. Individual damper sections shall not exceed 48” wide and 60” tall. Applications requiring larger dampers shall be achieved by combining single damper sections. One (1) actuator, at a minimum, shall be provided per section.

D. Frame. Damper frame construction shall be a minimum of 13 gauge galvanized steel channel or 3 mm (1/8”) extruded aluminum with reinforced corner bracing and continuously welded.

E. Blades. Damper blades shall not exceed 8” in width or 48” in length. Blades are required to be suitable for medium velocity performance of 2000 fpm at a minimum.

1. Damper blades and baffles shall be fabricated of minimum 16 gauge steel with corrosion resistant galvanized finish or 0.08” extruded aluminum at 6” width.

2. Damper blades mounted vertically shall be supported by thrust bearings

3. Dampers shall have a minimum of four brakes running the entire length.

F. Seals. All damper blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. Blade seals shall provide for a maximum leakage rate of 10 cfm per ft² at 4 iwc differential pressure. Provide air foil blades suitable for a wide-open face velocity of 1500 fpm.

1. Damper leakage shall be certified in accordance with AMCA Standard 500-D

G. Bearings. Damper shaft bearings shall be as recommended by manufacturer for application; nylon, cycoloy, olite® style oil impregnated sintered bronze or better.

H. Shafts. Shafts shall be a minimum of 1/2” diameter and be welded or riveted to the blade.

I. Outdoor Suitability. All outdoor air damper components shall be suitable for applications operating in the temperature range of -40˚F to 167˚F.

J. Linear Characterization. All Automatic Control Dampers in modulating applications shall be sized so as to achieve linear airflow characteristics.

K. Operating Linkages and Damper Accessories:

1. All operating linkages and/or damper accessories required for installation and application in accordance with specification design intent and manufacturer’s installation procedures shall be provided.

2. Operating linkages provided external to dampers (crank arms, connecting rods, shaft extensions, etc.) for transmitting motion from the actuator/operator to dampers shall be designed as to functionally operate a load equal to or in excess of 300% of the maximum required operating force for the damper.

3. Crank arms and connecting rods shall be adjustable. Linkages shall be brass, bronze, zinc-coated steel, or stainless steel.

4. Adjustments of crank arms shall control the position of the damper
5. Use of Operating Linkages external to damper drive shaft shall neither delay nor impede operation of the damper in a manner of performance less than a direct-coupled damper actuator. Operating linkages shall not under any circumstances be permitted to flex, warp, shift etc. under normal operation of connected damper sections.

2.07 AUTOMATIC CONTROL ACTUATORS

A. Electric Actuation. Unless otherwise specified or scheduled, all control actuators shall be electric/electronic direct-coupled type. Actuators shall have a means for reversing drive direction and a manual override accessible at the front cover.
   1. The actuator shall have electronic overload or stall protection to prevent damage to the actuator throughout rotation. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

B. Spring Return. Where shown, for power-failure or safety applications, an internal mechanical spring-return mechanism shall be built-in to the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
   1. All mechanical equipment with direct introduction of outside air shall require fail-safe spring return actuators.

C. Clutch/Gear Release. All actuators shall have an external manual clutch/gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 7 Nm (60 in-LB) torque capacity shall have a manual crank for this purpose.

D. Modulating Actuators. Unless otherwise specified or scheduled, all modulating actuators shall be positive positioning and accept a 0 to 10 VDC or 0 to 20 mA control signal and provide an operating range of 2-10 VDC or 4-20 mA.

E. Position Feedback. All actuators shall feature a visual position feedback indicator and shall provide a 2-10 VDC or 4-20 mA feedback signal.

F. Power. All 24 VAC/VDC actuators shall operate in Class 2 circuits.

G. Enclosure. Actuator casing and/or enclosures shall be appropriate to the application.
   1. Actuators used in or near outdoor air streams shall have NEMA 2 (IEC IP21) housings.
   2. Actuators exposed to moisture, in wet mechanical rooms or located outdoors shall be meet NEMA 4X (IEC IP66) requirements or as directed by the AHJ.

2.08 TEMPERATURE DEVICES

A. Analog Temperature Sensors. Analog temperature sensors shall be precision element thermistor type.

B. Duct Sensors. Duct temperature sensors shall include junction box for wiring connections and gasket to prevent air leakage and vibration noise.
   1. Single point duct temperature sensor probe shall consist of 316 stainless steel extending to the center of the duct.
   2. Averaging duct temperature sensor shall consist of a copper or stainless steel averaging element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Averaging sensors shall be a minimum of 1.5 m (5’) in length per 1 m² (10 ft²) of duct cross sectional area.
   3. Space Sensors. Space temperature sensor shall consist of an element within a ventilated cover aesthetically pleasing and specifically designed for permanent installation in a finished, occupied space.
      a. In private and semi-private spaces that serve full-time or full-time-equivalent occupants including but not limited to offices, work rooms, meeting rooms, conference rooms, etc., space sensors shall be provided with setpoint adjustment and occupancy bypass.
      b. In public spaces without full-time or full-time-equivalent occupants including but not limited to lobbies, hallways, atriums, break rooms, restrooms, stacks, mechanical spaces, etc., simple temperature sensor without setpoint shall be provided. Bypass shall be provided.
      c. Sensors with operator interface keypads and displays shall be provided as indicated or scheduled elsewhere.
4. Outdoor Air Temperature. Outdoor air temperature sensor shall consist of a single device sensor, ventilated non-metallic sun shield, utility box for terminations, and watertight gasket to prevent water seepage. One global sensor shall be provided and used for global control.


6. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL-Listed, vapor pressure type, with an element of 20' minimum length.
   a. Provide one (1) low-limit thermostat for each 20 ft² of coil face.
   b. Low-limit thermostat shall respond to the lowest temperature sensed in any 12" section of the element.
   c. Low-limit thermostats shall be manual-reset, DPDT-style with a minimum of one (1) normally-open contact and one (1) normally-closed contact.


8. Low-voltage Thermostats. Low-voltage thermostats shall be 24 VAC, bimetal-operated or electronic type with adjustable of fixed anticipation heater, concealed setpoint adjustment 55˚F to 85˚F setpoint range, 2˚F maximum differential and vented ABS plastic housing.

9. Line-voltage Thermostat. Line-voltage thermostats shall be UL-Listed bi-metal actuated, open contact type, enclosed, snap-switch type or equivalent solid-state type with adjustable of fixed anticipation heater, concealed setpoint adjustment 55˚F to 85˚F) setpoint range, 2˚F maximum differential and vented ABS plastic housing.

2.09 HUMIDITY DEVICES
   A. Duct Sensors. Duct-mounted humidity sensors shall have a sensing range of 20% to 80% RH and shall be provided with a sampling chamber.
   B. Space Sensors. Space sensors shall have a sensing range of 20% to 90% RH.
   C. Outdoor Air Sensors. Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH and shall be suitable for ambient conditions of -40˚F to 170˚F. One global sensor shall be provided and used for global control.
   D. Drift. Sensor drift shall not exceed 1% of full scale per year.

2.10 CURRENT TRANSMITTERS
   A. AC Current Transmitters. AC current transmitters shall be UL-Listed self-powered, combination split-core current transformer type with two-wire voltage (0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC) or current (4-20 mA) output.
      1. Ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A and 200 A full-scale with internal zero and span adjustment and ±1% full-scale accuracy at 500 ohm maximum burden.
      2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA certified.
   B. Current Transformers. Current transformers shall be UL/CSA recognized, split-core and completely encased (except for terminals) in approved plastic material. Transformers shall be selected for ±1% accuracy at 5 A full-scale output.

2.11 PRESSURE TRANSDUCERS
   A. Pressure Transducers. Pressure transducers shall have a linear voltage (0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC) or current (4-20 mA) output with field adjustable zero and span.
      1. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.

2.12 PRESSURE SWITCHES
   A. Differential Pressure Switches. Differential pressure switches provided as a part of this specification shall be UL-Listed, SPDT snap-acting, pilot-duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified.

2.13 FLOW SWITCHES
A. Flow Proving Switches. Flow proving switches provided as a part of this specification shall be differential pressure type UL-Listed, SPDT snap-acting, pilot-duty rated (125 VA minimum), NEMA 2 enclosure, with scale range and differential suitable for intended application or as specified.

2.14 RELAYS
A. Control Relays. Control relays shall be UL-Listed, enclosed with LED energized indicator. Contact rating, configuration and coil voltage shall be suitable for application. Coil current shall be less than 50 mA.

B. FAN SPEED CONTROLLERS
A. Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

C. TEMPERATURE CONTROL PANELS
D. Temperature Control Panels. Provide pedestal base or wall mounted local control enclosures to be fully enclosed NEMA 1 (IEC IP20) at a minimum with hinged door, key-lock latch and removable subpanels to house all control components appropriate to the environment, service, and/or as required by the code enforcing authorities and other AHJ.
   1. All enclosures shall be UL-Listed.
   2. Enclosures in mechanical rooms shall meet NEMA 2 (IEC IP21) requirements at a minimum or as directed by the AHJ.
   3. Enclosures in all locations not requiring NEMA 2 (IEC IP21) including occupied spaces, above ceilings and plenums shall be the same NEMA (IEC) classification as other enclosures located in the same environment, except if location requires additional protection due to potential vandalism or environmental conditions or as directed by the AHJ.
   4. Enclosures exposed to moisture, in wet mechanical rooms or located outdoors shall be meet NEMA 4X (IEC IP66) requirements or as directed by the AHJ.
   5. Unless otherwise required by local codes and/or AHJ, all enclosures shall be a minimum of 16 gauge steel or aluminum, totally enclosed on all sides and powder coated or painted with a baked enamel finish.

E. Power Supplies & Control Transformers. Control transformers and power supplies shall be UL-Listed. Provide Class 2 current-limiting type or over-current protection in both primary and secondary circuits for Class 2 service not to exceed 100 VA in accordance with the applicable following requirements or as directed by the AHJ.
   1. NEC 2011 (NFPA 70) Chapter 7 Article 725 – Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits
   2. NEC 2011 (NFPA 70) Chapter 9 Table 11(A) and Table 11(B).

F. DC Power Supplies. DC power supply output shall match output current and voltage requirements. Power supply shall be half-wave rectified type with the following minimum specifications:
   1. Output ripple: 5.0 mV maximum peak-to-peak.
   2. Regulation: 1.0% line and load combined.
   3. Response: 100 ms for 50% load changes.
   4. Built-in overvoltage and overcurrent protection and able to withstand a 150% current overload for a minimum of three (3) seconds without tripping or failure.

G. INTERCONNECTING WIRING & RACEWAYS
H. Wiring & Cable. All wiring regardless of service and/or voltage shall comply with the Contract Document Electrical System Specifications, the National Electric Code (NEC), CSA C22.1-12 and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ).
   All insulated wire to be copper conductors, UL labeled for 90 °C minimum service.

2.15 AIR FLOW MONITORS
A. Acceptable Manufacturers:
   1. EBTRON, Inc.

B. Approved performance equal:
1. Airflow Measurement Devices (AMD) with Temperature Output and Airflow Alarming Capability.

1.1 Products included in this section

2.0 ACCEPTABLE MANUFACTURERS

A. EBTRON, Inc. model GTx116-P+ is the basis of design

1. Basis of Design and Acceptable Manufacturers
   a. Airflow measurement devices shall use the principle of thermal dispersion and provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node.
      1) Thermal dispersion devices that indirectly heat a thermistor are not acceptable.
   b. Substitution requests for acceptance less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.
      1) For any product to be considered for substitution, a written document shall be submitted to the engineer detailing exceptions and compliance, section-by-section with supporting documentation, before an approval will be considered.
      2) Any product submitted as an equal shall be expected to comply with all performance capabilities and functional aspects of this specification.
   c. Excluded devices:
      1) Fan Inlet airflow measurement devices.
      2) Measurement technologies using “chip-in-glass”, “chip-in-epoxy” or other “chip” type thermistors for the heated sensor component are not acceptable.
      3) Pitot tubes, Pitot arrays, Piezo rings and other differential pressure based devices are not acceptable.
      4) Vortex shedding devices are not acceptable.

B. Products approved

1. Approved performance equal

2.1 PRODUCTS INCLUDED IN THIS SECTION

A. Airflow Measurement Devices (AMD) with Temperature Output and Airflow Alarming Capability

1. General
   a. Provide one AMD for each measurement location provided on the plans, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.
   b. Each AMD shall be provided with a microprocessor-based transmitter and one or more sensor probes.
      1) Devices that have electronic signal processing components on or in the sensor probe are not acceptable.
   c. Airflow measurement shall be field configurable to determine the average Actual or Standard mass airflow rate.
      1) Actual airflow rate calculations shall have the capability of being corrected by the transmitter for altitudes other than sea level.
   d. Temperature measurement shall be field configurable with velocity weighted average as the default, or manual selection of arithmetic average temperature.

2. Sensor Probes
   a. Sensor probes shall be constructed of gold anodized, 6063 aluminum alloy tube, 316 stainless steel tube are available when required.
   b. Sensor probe mounting brackets shall be constructed of 304 stainless steel.
   c. Probe internal wiring between the connecting cable and sensor nodes shall be Kynar coated copper.
1) PVC jacketed internal wiring is not acceptable.

d. Probe internal wiring connections shall consist of solder joints and spot welds.
   1) Internal wiring connections shall be sealed and protected from the elements. They shall be capable of direct exposure to water without affecting instrument operation.
   2) Connectors of any type within the probe are not acceptable.
   3) Printed circuit boards within the probe are not acceptable.

e. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/CL2P, UL/cUL Listed cable rated for exposures from -67° F to 392° F (-55° C to 200° C) and continuous and direct UV exposure.
   1) Plenum rated PVC jacket cables are not acceptable.

f. Each sensor probe cable shall be provided with a connector plug with gold plated pins for connection to the transmitter.

g. Each sensor probe shall contain one or more independently wired sensing nodes.

h. Sensor node airflow and temperature calibration data shall be stored in a serial memory chip in the cable connecting plug and not require matching or adjustments to the transmitter in the field.

i. Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Upon request, the manufacture shall provide a written independent laboratory test result of 100% survival rate in a 30 day saltwater and acid vapor test.
   1) Devices that use epoxy or glass encapsulated chip thermistors are not acceptable.
   2) Devices with exposed leads are not acceptable.

j. Each sensor node shall be individually calibrated at a minimum of 3 temperatures to NIST-traceable temperature standards.

k. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of ±2% of reading over the entire calibrated airflow range of 0 to 5,000 FPM (25.4 m/s).
   1) Upon request the manufacture shall submit for AMD approval a copy of the NIST report of calibration used for the reference standard used.
      i. Devices claiming NIST traceability to third party laboratories and not directly to NIST are not acceptable
      ii. Devices calibrated against standards other than the NIST LDA are not acceptable.

l. Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.

m. The installed airflow accuracy shall be:
   1) Ducts - ±3% of reading when installed in accordance with the manufactures recommended placement guidelines.
   2) Non-ducted Outdoor Air intakes – better than or equal to ±5% of reading when installed in accordance with the manufactures recommended placement guidelines.

n. Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with this requirement over the entire operating range.

o. Each sensing node shall have a temperature accuracy of ±0.15° F (0.08° C) over an operating range of -20° F to 160° F. (-28.9° C to 71.1° C) and humidity range of 0 to 100% RH.

p. The number of independent sensor nodes provided shall be as follows:

<table>
<thead>
<tr>
<th>Area ft² [m²]</th>
<th># Sensor Nodes</th>
</tr>
</thead>
</table>

INSTRUMENTATION AND CONTROLS FOR HVAC
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3. Transmitter
   a. A remotely located microprocessor-based transmitter shall be provided for each measurement location.
   b. The transmitter shall be comprised of a main circuit board and interchangeable interface card.
   c. All printed circuit board interconnects, edge fingers, receptacle plug pins and PCB test points shall be gold plated.
   d. All printed circuit boards shall be electroless nickel immersion gold (ENIG) plated.
   e. All integrated circuitry shall be temperature rated as ‘industrial-grade’. Submissions containing ‘commercial-grade’ integrated circuitry are not acceptable.
   f. The transmitter shall be capable of determining the airflow rate and temperature average of all connected sensor nodes in an array for a single location.
      1) Separate integration buffers shall be provided for display airflow output, airflow signal output (analog and network) and individual sensor output (IR-interface).
   g. The transmitter shall be capable of providing a high and/or low airflow alarm with user-defined set point and % of set point tolerance. Alarm shall be capable of being manually or automatically reset and low-limit cutoff value may be selected to disable the alarm. An alarm delay function shall also be field defined.
   h. The transmitter shall be capable of identifying an AMD malfunction via the system status alarm and ignore any sensor node that is in a fault condition.
   i. The transmitter shall be capable of field configuration, diagnostics and include Field Output Adjustment Wizard that allows for a one or two point field adjustment to factory calibration for installations that require adjustment.
   j. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display.
   k. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals (AO1=airflow, AO2=temperature or alarm), in combination with [select one of the following]
      1) one isolated RS-485 (field selectable BACnet MS/TP or Modbus RTU) network connection, or
      2) one isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection.
   l. The analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate and the second output (AO2) shall be field configurable to provide one of the following:
      1) temperature
      2) low and/or high airflow user-defined set point alarm, or
      3) system status alarm

| ≤ 0.5  |
| ≤ 0.046 | 1 |
| > 0.5 & ≤ 1 | ≤ 0.092 | 2 |
| > 1 & ≤ 2 | > 0.092 & ≤ 0.185 | 4 |
| > 2 & ≤ 4 | > 0.185 & ≤ 0.371 | 6 |
| > 4 & ≤ 8 | > 0.371 & ≤ 0.743 | 8 |
| > 8 & ≤ 12 | > 0.743 & ≤ 1.11 | 12 |
| > 12 & ≤ 14 | > 1.11 & ≤ 1.30 | 14 |
| > 14 | > 1.30 | 16 |

1) A total of 4 probes shall be required for openings with an aspect ratio ≤ 1.5 and with an area ≥ 25 ft² (≥ 2.32 m²).
m. The transmitter shall also be available with a single isolated LonWorks Free Topology network interface. Transmitters shall be available alternatively with one USB connection for thumb-drive data logging of sensor data. Neither of these options shall include analog output signals.

n. The network communications RS-485 (BACnet MS/TP or Modbus RTU) or Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) shall provide: the average airflow rate, temperature, hi and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures. Individual node airflow rates and temperatures shall NOT be available via the network with Lon.

o. The transmitter shall have an on-off power switch. Isolation transformers shall not be required.

p. The transmitter shall be powered by 24 VAC (22.8 to 26.4 under load) @20 V-A maximum and use a switching power supply that is over-current and over-voltage protected.

q. The transmitter shall use a “watchdog” timer circuit to ensure automatic reset after power disruption, transients and brown-outs.

r. Each transmitter shall have an operating temperature range of -20°F to 120°F (-28.9°C to 48.9°C) and humidity range of 5 to 95% RH.

4. Listings and Certifications

a. The AMD shall be UL/cUL 873 Listed as an assembly.

b. Devices claiming compliance with the UL Listing based on individual UL component listing are not acceptable.

c. All network-capable AMD models supplied with RS-485 interface and BACnet protocol shall be BTL Listed.

PART 3 - EXECUTION

3.01 GENERAL

A. The DDC System, all of its components, its execution and compliance with this specification is the responsibility of the DDC System Contractor. All control system components shall be installed in locations as required to properly sense the controlled medium and perform according to the intent of the specified sequence of operations and the requirements of the contract drawings and this specification.

B. Unless specified otherwise, all DDC System devices and components as required to appropriately satisfy the intent of the specified sequence of operations and the requirements of the contract drawings and this specification shall be provided as a part of this section.

C. Training. Provide four (4) days of on-site or classroom training sessions throughout the contract period for personnel designated by the Owner.

1. Provide two (2) days of training immediately following demonstration and acceptance.

2. Provide one (1) day of training at 6 and 12 months following demonstration and acceptance.

D. EXAMINATION

E. The project plans and contract documents shall be thoroughly examined for control device and equipment locations. The DDC System Contractor shall inspect the site to verify that the equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the project construction management team for resolution before rough-in work is started.

F. The DDC System Contractor shall examine the drawings and specifications for additional work requirements. If space appears inadequate or any discrepancies, conflicts, or omissions occur the DDC System Contractor shall report said issues to the project construction management team for resolution and written instruction to proceed.

G. PROTECTION

H. The DDC System Contractor shall be responsible for his/her work and equipment until finally inspected, tested and accepted. The DDC System Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not
immediately installed. The DDC System Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent damage/contamination by foreign objects and construction debris.

I. COORDINATION

J. Where the mechanical work will be installed in close proximity to, or will interfere with work of other trades, the DDC System Contractor shall assist in coordinating space requirements.

K. Coordinate and schedule work with all other trades in the same area, or with work that is dependent upon other trades to facilitate mutual progress. Report all conflicts and anticipated delays to the project construction management team for resolution immediately upon identification.

L. Life Safety

1. Duct smoke detectors required for air handling unit shut down are furnished under another division of this specification. The DDC System Contractor shall interlock smoke detectors to air handling units for shut down as described in the Sequences of Operation.

2. Smoke dampers and actuators required for duct smoke isolation are provided under another division of this specification. The DDC System Contractor shall interlock smoke detectors to air handling units as described in the Sequences of Operation.

M. Other sections and/or divisions of this specification include controls and control devices that are to be a part of or interfaced to the DDC System specified in this section. These devices shall be integrated into the DDC System and coordinated by the DDC System Contractor as follows:

1. All communication and network media and equipment integrated with the DDC System provided by any Contractor or Vendor shall comply with the requirements of this specification.

2. The Contractor/Supplier furnishing and/or providing any controls products to be integrated to the DDC System are responsible for the configuration, programming, start-up, testing, and proof-of-performance of that product to meet the requirements of the Sequences of Operation.

3. The DDC System Contractor shall coordinate resolution of incompatibilities that arise between the control products provided as a part of this section and products provided as a part of other sections or divisions of the specification.

I. Coordinate equipment with Section 260923 "Lighting Controls" and Section 260933 "Central Dimming Controls" to achieve compatibility with equipment that interfaces with that system.

J. Coordinate equipment with Section 283111 "Digital, Addressable Fire-Alarm System" to achieve compatibility with equipment that interfaces with that system.

M. Coordinate equipment with Section 262416 "Panelboards" to achieve compatibility with starter coils and annunciation devices.

3.02 GENERAL WORKMANSHIP

A. DDC System installation shall be performed by professionals in a workmanlike manner consistent with acceptable industry standards for performance and in compliance with the contract documents, Project Electrical System Specifications, the National Electric Code (NEC), CSA C22.1-12 and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ) and in compliance with the following at a minimum:

1. Installation of all DDC devices, enclosures, wiring, equipment, control devices and sensors shall be installed in accordance with the manufacturers’ recommended installation procedures and as specified.

2. All control devices are to be provided and installed with all required gaskets, seals, flanges, connection enclosures, thermal compounds, insulation, piping, fittings and valves as required for design operation, isolation, equalization, purging and calibration.

3. Install all equipment as to be readily accessible as defined by Chapter 1, Article 100, Part A of the National Electric Code (NEC) or CSA C22.1-12 Rule 2 (as applicable) and such that it provides sufficient clearance for system maintenance, component service, calibration, removal, repair or replacement.

4. Install all equipment, piping, and wiring/raceway parallel to building lines.

5. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

6. All control devices mounted outdoors shall be protected by a weather-shield, integral outdoor enclosure, etc. and from ambient elements in such a manner as to not impede design functionality and/or sensing.
7. Dielectric isolation shall be provided where dissimilar metals are used in installation for connection and support.
8. Penetrations through and mounting holes in the building exterior associated with the DDC System installation shall be sealed and made water-tight.

3.03 FIELD QUALITY CONTROL
   A. DDC System Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
   B. DDC System Contractor shall have all work inspected as required by local and/or regional code enforcing authorities and/or AHJ.

3.04 DDC SYSTEM ARCHITECTURE
   A. A Protocol Implementation Conformance Statement (PI CS) including a BACnet® Interoperability Building Block (BIBB) table shall be provided for each DDC device (hardware and software) provided under this specification.
   B. No single MS/TP (Master-Slave/Token-Passing) segment shall exceed 32 full-load nodes.
   C. No single MS/TP segment shall exceed 32 devices that do not support Read Property Multiple (RPM) and Segmentation for both Transmit and Receive. For the purposes of this specification, devices that do not support both shall be considered full-load nodes.
   D. The DDC system as provided and installed under this specification shall implement the following BACnet® data links only:
      1. Point-to-Point (PTP)
      2. Master-Slave/Token-Passing (MS/TP)
      3. Ethernet (ISO 8802.3)
      4. IP (B/IP)
      5. All other BACnet® data links shall be excluded from this project.
   E. Each mechanical system and/or piece of mechanical equipment shall be controlled by one (1) dedicated DDC device with sufficient hardware and software capabilities that it shall be connected to all field devices associated with the mechanical system and/or piece of mechanical equipment. Distributed control of one (1) mechanical system and/or piece of mechanical equipment by multiple controllers shall be strictly prohibited.
   F. Where any licensing is required, the system shall be delivered with sufficient licensing for 100% expansion of objects, networks, devices and operator workstations for a minimum of five (5) years from the acceptance date as a part of this contract.
   G. The DDC system shall support the ability for a common BACnet® Broadcast Management Device (BBMD) Broadcast Distribution Table (BDT) to be configured once and the broadcasted to all BBMDs on the internetwork. Where the BDT must be manually configured, the system contractor shall be responsible for maintenance and configuration of all Internetwork BDTs for the duration of the warranty period.

3.05 QUALITY ASSURANCE
   A. Upon request the DDC System Manufacturer shall provide documentation supporting certified compliance with ISO 9001:2008 containing the ISO 9001:2008 Certification Mark from an applicable registrar.
   B. The DDC System Contractor shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship provided under this specification section.
   C. Upon request, the DDC System Contractor shall present the following:
      1. Certification of technical training from the DDC System Manufacturer including hours of instruction and course outline for each installer, technician and application engineer that will be involved on this project.
      2. Resumes for each installer, technician, application engineer and project manager that will be involved on this project.
      3. References from previous projects of comparable scope, type and service specified
      4. All qualifications shall be provided within seven (7) calendar days of initial request
D. The DDC System Contractor shall maintain a comprehensive service office within 100 miles (160 km) of the project location by the bid date and at a minimum until the completion of the warranty period.
   1. Comprehensive service office shall be defined as a full-time operational center where DDC system professionals are regularly employed performing at a minimum the responsibilities and services of installation, design, application engineering, service and project management of complete DDC systems consistent in scope, type and service specified.

3.06 WARRANTY
A. The DDC System Manufacturer shall provide a warranty certificate covering all DDC devices for a period of at least five (5) years from the date of substantial completion.

3.07 CONTROLLERS
A. Provide a separate, dedicated DDC controller for each mechanical system or piece of equipment. Multiple pieces of mechanical equipment comprising one mechanical system may be controlled by a single DDC controller provided that all of the points associated with the equipment are hosted by the controller. Distributed control of one piece of mechanical equipment shall not be performed by multiple DDC controllers.
   1. Objects used for trim and respond or demand-based reset control such as outdoor air temperature, space temperatures or terminal loads are not included in this requirement.

B. Building level controllers shall be selected to provide a minimum of 20% spare I/O point capacity for each point type on each controller.
   1. Where universal inputs are not provided, 20% spare inputs of each individual type (e.g., analog, binary, etc.) are required.
   2. Where universal outputs are not provided, 20% spare outputs of each individual type (e.g., analog, binary, etc.) are required.

C. For unitary and space-mounted controllers, where software-selectable universal inputs are not available, one (1) spare analog input and one (1) spare binary input shall be required on each terminal unit controller after the requirements of the sequence of operation specified in the contract documents have been satisfied.

D. Operator Override. All DDC controllers shall support operator-initiated timed overrides of hardware and software objects with user-configurable override periods. When the override period has expired, the controller shall automatically return the object to the automatic state without any additional action on the part of the Operator.
   1. The timed override functionality shall exist entirely in the controller. A workstation shall not be required for the execution of the time period nor for returning the object to automatic.

3.08 BUILDING LEVEL CONTROLLERS
A. The building level controllers provided shall comply with all relevant sections of this specification.
B. Provide one (1) dedicated BACnet® Building Controller (B-BC) for the execution of global strategies and for each large point-count major mechanical system and/or piece of equipment.
   1. Any application exceeding eight (8) inputs or eight (8) outputs shall be considered a building-level application and shall require a dedicated building-level controller.

C. Each building level controller shall be provided with an integral power switch or a dedicated fused transformer and switch inside the enclosure.

D. All building level controllers provided under this specification shall be required to provide the following simultaneous intrinsic and enabled physical communication networks at a minimum:
   1. One (1) ISO 8802-3 Ethernet port @ 100 Mbps.
   2. One (1) EIA-232 port @ 115.2 Kbps.
   3. Two (2) EIA-485 ports @ 76.8 Kbps.

E. All building level controllers provided under this specification shall be required to provide the following simultaneous communication protocols and/or data links at a minimum:
   1. ANSI/ASHRAE Standard 135: BACnet®
d. Two (2) BACnet®/IP: ANSI/ASHRAE Standard 135 Annex J.
2. Modbus
   a. Remote Terminal Unit (RTU) Master or Slave
   b. TCP Master or Slave
3. Simple Mail Transfer Protocol (SMTP)
   a. Transport Layer Security (TLS) for SMTP must be supported including compatibility with standard free email services (e.g., Gmail, Yahoo!, Outlook.com).
   b. The ability to manage custom TLS certificates from SMTP must be supported.
   c. The ability to transmit a simple test email to verify SMTP configuration with a single operator action (e.g., pressing a Test Email button) must be provided.
4. Simple Network Management Protocol (SNMP)
F. All inputs shall be provided with a proportional brightness LED to display the status of each individual input.
G. All outputs shall be provided with a proportional brightness LED to display the status of each individual output.
H. All hardware outputs shall be provided with a physical Hand/Off/Auto switch.
   1. All analog outputs shall also be provided with a potentiometer for manual adjustment of voltage signal in the Hand position.
   2. Hand/Off/Auto switch position feedback shall be monitored and displayed by the operating system of the controller.
   3. Controller shall alarm when each Hand/Off/Auto switch is not in the Auto position.

3.09 COMMUNICATING SPACE SENSORS
A. The communicating space sensors provided shall comply with all relevant sections of this specification.
B. The communication status and reliability of all communicating sensors shall be actively monitored by the system. When communication is lost with any communicating sensor, the system shall be capable of generating an alarm and performing automatic control strategy response until communication is restored.
   1. If the system is not capable of performing custom, freely-programmable and automatic control strategy response as a result of a loss of sensor communication, communicating sensors may be not be used.
C. All space mounted communicating sensors provided under this specification shall be available with the following the integral hardware at a minimum:
   1. Temperature
   2. Setpoint
   3. Relative Humidity
   4. Bypass
   5. PIR Occupancy
      a. Range: 5m/16’
   6. CO₂
   7. Auxiliary onboard inputs/outputs
      a. Thermistor or dry-contact
      b. Dry-contact outputs

3.10 AUTOMATIC CONTROL ACTUATORS
A. Mount and link all control actuators according to manufacturer’s instructions.
   1. Check operation of damper/valve and actuator combination to confirm that actuator modulates smoothly throughout full stroke to both open and closed positions.
   2. To compress seats when spring-return actuators are used on normally-closed dampers, power actuator to approximately 5˚ open position, manually close the damper, and then tighten linkages.
B. All actuators shall be direct-coupled unless otherwise scheduled or indicated by manufacturer.
C. Minimum torque and power output requirements of actuators shall not be less than 125% of the required design load.
D. When the associated mechanical system or equipment is not in operation, control actuators shall remain in their “off” positions as indicated in the Sequences of Operation.

3.11 TEMPERATURE SENSORS
A. All sensors shall be installed in accordance with the manufacturer’s recommendations consistent with acceptable industry standards for performance compliant with the requirements of this specification.
B. Mount sensors rigidly and adequately for the environment within the sensor operates.
C. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings. Where necessary due to structural cavities, masonry walls, proximity to exterior openings, unconditioned spaces, etc. insulated mounting base shall prevent temperature of mounting location from affecting sensor temperature reading.
D. Space temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
E. Sensors used in packaged rooftop equipment shall be of the averaging type.
F. All averaging sensors shall be installed in a serpentine manner vertically across the unit. Each bend shall be supported with a capillary clip.
G. Low-limit sensors and/or thermostats shall be installed in a serpentine manner horizontally across the unit. Each bend shall be supported with a capillary clip. Provide a minimum of 1’ of sensing element for each 1 ft$^2$ of coil area.
H. Outdoor air sensors shall be mounted outside on a northern exposure as high as serviceable on the building. The sensor shall be mounted within a ventilated enclosure to shield the sensor from the effects of the sun. The sensor location shall be selected such that it may not be affected by artificial and/or mechanical airstreams (i.e., building exhaust, building relief, &c.).
I. In condensing environments use stainless steel sensing element and capillary mounting clips.
J. Sensor guards shall be provided to protect sensor from damage in high-impact and/or high-traffic areas and/or where vandalism is a concern. Provide guards on all wall mounted sensors in areas accessible to the public.
K. Sensors shall be manually calibrated on site so that the wiring length and termination does not detract from the sensor accuracy specified.

3.12 PRESSURE SENSORS
A. Locate all pressure transducers (except for those controlling air terminal units) in field device panels, not on mechanical equipment or ductwork, as close as possible to the sensing point and use tubing sized such as to prevent signal phase lag.
B. Pressure transducer tubing shall be connected to a pitot tube or other pressure/airflow sensing device. Under no circumstances shall tubing pass through equipment housing or ductwork.
   1. Pitot tube probe shall be made of brass or aluminum with 8 inches of lead tube allowing insertion into duct.
C. The piping to pressure ports on all pressure transmitters shall contain a capped test port adjacent to the transmitter.
D. Static pressure sensing taps shall face down-stream in the airflow so as to eliminate velocity pressure effects.
E. Building static pressure sensors high-pressure port connected to a sensing probe installed in the space and the low-pressure port connected to an outdoor air static pressure sensing probe through a high-volume accumulator. The tubing for both the high-pressure and the low-pressure ports shall be routed through a surge dampener installed between the transmitter and the sensing elements.
F. Differential pressure taps shall be installed such that true differential of the monitored medium may be accurately sensed.
3.13 TEMPERATURE CONTROL PANELS

A. Unless otherwise directed by the AHJ, all temperature control panels and enclosures shall be located as indicated such that visual observation and adjustment can be accomplished while standing flatfooted on the floor in a convenient location adjacent to the equipment served. Install all equipment in readily accessible location as defined by Chapter 1 Article 100 Part A of the NEC or CSA C22.1-12 Rule 2 (as applicable).

B. All temperature control panels shall have keyed, locking latches and shall be keyed commonly such that one key shall open all enclosures. All panels shall be labeled with permanent equipment labels.

C. Provide each DDC panel with a surge suppressor, electrical disconnect, control fuse, and control transformer; all sized and provided by the control system contractor.

D. Interconnections between internal termination points and face and/or panel-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL-Listed for 600 volt service, individually identified per control drawings with adequate clearance for field connections. All terminals shall be labeled.

1. Provide insulated, modular, feed-through, clamp-style recessed captive screw-type terminal blocks suitable for rail-mounting with end plates and partitions for the termination of all field wiring in temperature control panels.

2. Field wiring to equipment with integral terminals and/or unitary equipment shall not be required to have terminal blocks.

E. All high-voltage wiring consistent with the definitions of NEC/CSA Class 1 and all low-voltage wiring consistent with the definitions of NEC/CSA Class 2 must be strictly separated by barriers, raceways or sub-panels according to the requirements of the NEC Chapter 7 Article 725 – Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits and the CSA Canadian Electrical Code, Part 1 Rule 16-212 Separation of Class 2 circuit conductors from other circuits.

F. Provide laminated nameplates or tags for all control system components. Unless otherwise directed in this specification or by the AHJ, nameplates shall be minimum 1 inch by 3 inches (2.5 cm X 7.5 cm), with minimum ¼ inch (6 mm) high block lettering. Nameplates for devices smaller than 1 inch by 3 inches (2.5 cm X 7.5 cm) shall be attached to adjacent surface.

G. A legible reproduction of the “As-built” application engineering for the system served shall be laminated in clear plastic and mounted within each enclosure.

3.14 POWER SUPPLIES AND LINE FILTERING

A. All connected loads shall not exceed 80% of the faceplate rating for each power supply or transformer.

3.15 WIRING

A. DDC System control wiring shall be performed by professionals in a workmanlike manner consistent with acceptable industry standards for performance and in compliance with the contract documents, Project Electrical System Specifications, the National Electric Code (NEC), CSA C22.1-12 and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ). When non-code compliance requirements of the Electrical System Specifications and this specification section differ, this section shall take precedence.

B. Unless otherwise specified it shall be the responsibility of the DDC System Contractor to provide all of the wiring necessary to provide a complete DDC System in compliance with the requirements of this specification.

C. All wiring consistent with the definitions of NEC/CSA Class 1 (line voltage) shall be installed in UL-Listed raceway or conduit according to the requirements of the NEC, CSA C22.1-12, the Electrical System Specifications and any/all applicable local codes and/or AHJ.

D. All wiring consistent with the definitions of NEC/CSA Class 2 (low voltage) control wiring shall be sub-fused as required and installed according to the requirements of the NEC, CSA C22.1-12, the Electrical System Specifications and any/all applicable local codes and/or AHJ.

E. Class 2 wiring concealed in accessible locations not installed in UL-Listed raceways or conduit may be used provided that the cable is UL-Listed for the intended application. All exposed wiring shall be suitable for use in return air plenums.
1. When Class 2 wiring is installed exposed, wiring is to be routed parallel or perpendicular (right-angles) with building and/or mechanical lines and neatly tied at 2 m (6’) intervals.

2. Exposed cabling shall be mechanically supported to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping or ceiling suspension systems.

3. Exposed cabling shall be installed in sleeves where the route passes through walls, floors and other partitions. Maintain fire, smoke, envelope and pressure ratings of each space.

F. All wiring in mechanical, electrical or service rooms, or where subject to mechanical damage shall be installed in UL-Listed raceway or conduit.

G. Class 2 wiring shall not be installed in raceways or conduit containing Class 1 wiring. Junction boxes, enclosures and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays, transformers, CTs, etc.). Refer to the requirements of the applicable code enforcing authorities and AHJ.

1. NEC Chapter 7 Article 725 – Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits.

2. CSA C22.1-12 Rule 16-212 Separation of Class 2 circuit conductors from other circuits

H. Sizing and selection of raceways, enclosures and conduit shall be the responsibility of the DDC System Contractor in keeping with the manufacturer’s recommendations and the requirements of NEC, CSA C22.1-12, the Electrical System Specifications and any/all applicable local codes and/or AHJ.

1. Conceal all raceways and conduit, except within mechanical, electrical or service spaces.

2. Install raceways and conduit to maintain a minimum clearance of 15 cm (6”) from high-temperature equipment (e.g., steam lines, flues, etc.).

3. Secure and support raceways and conduit to the structure per the manufacturer’s recommendations. Raceways and conduit may not be hung on flexible straps or tie rods, nor may they be attached to ductwork.

4. Comply with the requirements of the Electrical System Specifications when raceways or conduit crosses building expansion joints.

5. Include a minimum of one (1) pull string in each raceway or conduit.

I. Flexible metal raceways, liquid-tight and other non-rigid conduit shall not exceed 1 m, (3’) in length and shall be mechanically supported at each end.

1. Flexible metal raceways, liquid-tight and other non-rigid conduit smaller than 12 mm (0.5”) shall not be used.

J. Wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be made at a terminal block.

1. Wire-to-wire connections shall be made in enclosures or approved junction boxes with a maximum fill of 50%.

K. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

L. Use color-coded conductors consistently throughout the entire DDC System installation.

M. Maximum allowable voltage for control wiring shall be 120 volts.

N. The DDC System Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

O. Maximum pulling, tension, and bend radius for cable installation as specified by the manufacturer shall not be exceeded during installation.

P. The DDC System Contractor shall verify integrity of all wiring to ensure continuity and freedom from shorts and grounds after the installation is complete.

Q. When any cable enters or exits the building a lightning arrester must be installed between the conductors and ground. The lightning arrester shall be installed according to the manufacturer’s recommendations.

3.16 COMMUNICATION WIRING

A. Communication and network wiring shall adhere to the Wiring article in Part 3 of this specification and the manufacturer’s recommendations.

B. Communication wiring shall not be installed in any raceway or conduit with Class 1 or Class 2 wiring.
C. All communication wiring shall be installed as continuous lengths, with no splices permitted between termination points.

D. All communication cabling shall be labelled to indicate origination and destination devices.

E. All communications shielding shall be grounded as per manufacturer’s recommendations and in accordance with the NEC/CSA (as applicable).

F. Communications wiring shall be suitable for use in a plenum return system.

3.17 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels shall be labelled at each end within 2’ of the termination with the BACnet® object instance or termination number.

B. Manufacturer’s name plates and UL or CSA labels are to be visible and legible after equipment is installed.

C. All labels and identifiers shall match record documents.

3.18 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and data logging with a minimum of 25% of available memory remaining free for future use.

B. At time of acceptance, all operating systems, DDC System software and hardware shall be the latest official release version available.

C. Unless otherwise specified, DDC System shall be programmed using a standard naming convention. Objects names shall be modular in design, allowing easy operator interface without the use of a written object index. Use the following naming convention: AA-BBBBCCCC-DDDDEE where
   1. AA is used to designate the service location (e.g., room, floor, building, etc.).
   2. BBBB is used to designate the mechanical system with which the object is associated (e.g., AH, CHWS, HTG, CLG, LTG, etc.).
   3. CCC represents specific mechanical systems or pieces of equipment (e.g., 01, etc.).
   4. DDDD represents the equipment, device or material referenced (e.g., SF (supply fan), RF (return fan), DA (discharge air), etc.).
   5. EE represents the action or state of the equipment or measured medium (e.g., T (temperature), RH (relative humidity), P (pressure), etc.).

D. Program the DDC System to adhere to this specification and to fully incorporate the features described. Optimize the program to provide the Sequences of Operation, minimize energy consumption and prolong equipment life.
   1. All DDC System programming necessary for the operation of the system to satisfy the design intention and performance requirements, but not specified in this document, shall be provided by the DDC System Contractor at the direction of the Engineer.
   2. Imbed in the programming sufficient comment statements and descriptions to clearly describe each section of the program. Comments shall reflect the language of the specified sequences of operation.

E. Provide graphical user interface (GUI) consistent with the requirements of this specification and the Sequences of Operation. At a minimum:
   1. Provide dynamic graphics for all mechanical systems and/or each individual piece of mechanical equipment
   2. All physical hardware, sensors, control devices and setpoints shall be visible in graphical format.

F. All hardware inputs shall be programmed with appropriate alarms, configured to indicate genuine alarm conditions and/or failure to control while preventing nuisance alarm notification.

G. Unless otherwise specified, all setpoints shall be adjustable

H. At a minimum, every analog hardware point shall be trended and every binary hardware point shall have active and cycle times logged consistent with the specification requirements for trend logs and runtime logs. At a minimum, all software (virtual) setpoints, control loops and operational modes shall be likewise trended and/or logged.
   1. Interrelated objects shall be logically grouped into Trend Log Multiple objects for individual mechanical and building systems. Unless otherwise scheduled, initial set-up shall be to log values once every 15 minutes.
I. The system shall observe the following standard BACnet® command priorities (from highest to lowest):
   1. Smoke Control and Life Safety (Priority Level 1 & 2)
   3. Energy Management (Priority Level 9)
   4. Normal Automatic Control (Priority Level 10)

3.19 TEST & BALANCE
   A. The DDC System Contractor shall provide a single set of all tools required to interface with the System for the purposes of Test & Balance.
   B. The DDC System Contractor shall provide instruction in the use of all tools required to interface with the System for the purposes of Test & Balance.
   C. The DDC System Contractor shall provide a qualified technician to assist in the test & balance for a period of eight (8) hours.

3.20 DDC SYSTEM CHECK-OUT AND TESTING
   A. All testing listed in this article shall be performed by the DDC System Contractor. This testing shall be completed before system demonstration is initiated.
      1. The DDC System Contractor shall furnish all of the necessary labor and test and calibration apparatus required to calibrate and prepare for service all instruments, controls, and accessory equipment provided under this specification.
      2. Verify that all control terminations are tight and all control wiring is proper and free from shorts and faults.
      3. Enable normal operational control and verify calibration of all input devices individually according to manufacturer’s recommendations.
      4. Verify the operation of all output devices including action, normal positions, fail-safe positions, start and span, and travel.
      5. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation.
         a. Tune all control loops and optimum start/stop routines
         b. Check each alarm separately by providing an appropriate signal to trip the alarm
         c. Trip all safeties and interlocks to verify proper operation and fail-safe response
   B. As each device is tested a log shall be completed showing the date, technician’s initials and any corrective action taken as a result of operational failures. This log shall be submitted prior to scheduling acceptance demonstration and for inclusion in the final O&M manuals.

3.21 CONTROL ACCEPTANCE AND DEMONSTRATION
   A. Prior to acceptance, the DDC System shall undergo a series of performance tests to verify proper operation and compliance with this specification.
   B. The tests described in this section are in addition and subsequent to the tests necessary for start-up, tuning, debugging and compliance with the requirements of the Check-out and Testing section of this specification. The Engineer or an appointed representative may be present at the tests specified in this section and shall be notified ten (10) working days prior to the testing procedures.
   C. The DDC System Contractor shall provide at least two (2) qualified technical personnel equipped with means for two-way communication to demonstrate the actual operation of all control operations and modes including occupied, unoccupied, seasonal changeover and emergency/fail-safe operation.
      1. Compliance with this specification shall be demonstrated including all specification sections, schedules, drawings and Sequences of Operation.
   D. Demonstrate operator interface compliance with the requirements of the specification.
   E. Additionally, the following shall be demonstrated:
      1. Control loop response shall be proven in the form of trend data in a graphical format displaying the actual response to process variables of each control loop.
         a. Trends shall include the process variable, setpoint, loop output and physical output position.
b. Trends shall show the loop’s response to a change in setpoint which represents a change in output equal to at least 25% of its full range.
c. The sampling rate shall be between 10 seconds and 3 minutes.
d. Leading or following loops shall be required to be tuned by the DDC System Contractor.
2. Operational logs for each system that demonstrate normal operation.
   a. Trends shall include the process variable, setpoint, loop output and physical output position, operational mode and equipment status.
   b. Trends shall cover three (3) 48-hour periods with a sampling interval of not more than 10 minutes.
3. At the discretion of the Owner/Engineer trends from a random sampling of 25% of unitary controllers/applications may be submitted.
4. Database backup of the entire network and database restoration for selected controllers.
F. As each device is tested a log shall be completed showing the date, technician’s initials and any corrective action taken as a result of operational failures.
G. The DDC System Contractor shall display using a third-party data packet analytical tool that all DDC System data including operator interface requests are being performed using BACnet®.
H. Any tests that fail to demonstrate the operational compliance of the DDC System shall be repeated at a later date when the issues have been resolved. The DDC System Contractor shall be responsible for any necessary repairs or revisions to successfully complete all tests.
I. When all of the tests and documentation described herein have been successfully completed to the satisfaction of the specification, the Owner and the Engineer the DDC System shall be accepted as complete within fourteen (14) calendar days.
   1. Any tests that cannot be performed due to circumstances beyond the control of the DDC System Contractor may be performed at the discretion of the Owner after acceptance and as a part of the warranty period.

3.22 COMMISSIONING
A. The DDC system contractor shall furnish all labor and test calibration equipment required for commissioning of the building HVAC system.
B. The DOC contractor shall provide trends as requested by the commissioning authority.

3.23 CLEANING
A. The DDC System Contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his/her control as soon as their contents have been removed.
B. At the completion of work in any area the DDC System Contractor shall clean all work, equipment, etc. keeping it free from dust, dirt, debris, etc.
C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any other factory finish damage shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed or damaged shall be replaced with new material and painted to match the adjacent areas.

3.24 TRAINING
A. The DDC System Contractor shall provide instruction on the adjustment, operation and maintenance of the DDC System including all hardware and software provided and installed in compliance with the requirements of this specification.
   1. Training shall be performed by a manufacturer’s representative and/or instructor or a manufacturer-trained application engineer and/or technician with sufficient experience in the installation, programming and operation of the DDC system.
   2. All training equipment and material shall be provided by this Contractor.
B. Training in the operation of the DDC System shall be performed utilizing a BACnet® network of working controllers representative of the installed network and/or the Owner’s facility and shall include:
   1. Overview of the installed system and network architecture
   2. DDC system components
3. Graphical User Interface (GUI) operation
4. Day-to-day operations including modification of system setpoints, schedules, calendars, manual overrides, trending, log retrieval, alarm handling, etc.
5. Software operation, including navigating the workstation displays, database management, troubleshooting, diagnostics, report generation, etc.
6. Database design and modification including adding objects, modifying routines, optimizing operation, etc.
7. General operation of the workstation hardware and peripherals

C. On-site walk-through shall cover the deployment and execution of the complete DDC System and components including:
   2. Location of all panels, enclosures, controllers, devices, sensors, etc. and equipment and panel lay-out.
   3. Hardware preventive maintenance, calibration, troubleshooting, maintenance and repair.
   4. Proper use of service tools and materials.

3.25 INSTRUCTIONS TO OTHER CONTRACTORS

A. Control Damper Installation. Control dampers shall be installed in accordance with the manufacturer’s recommendations and in compliance with this specification.
   1. Damper submittals shall be coordinated for type, quantity and size to ensure compatibility with sheet metal design.
   2. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Inside clear duct openings shall measure 6 mm (1/4") larger than damper actual outside clear dimensions and shall be square, straight and level.
   3. Individual damper sections as well as entire multiple section assemblies must be completely square and free from racking, twisting or binding. Diagonal measurements from upper corners to opposite lower corners must be within 3 mm (1/8") of one another.
   4. Unless specifically designed for vertical blade orientation, dampers must be installed with blade axis horizontal.
   5. Damper blades, shafts, and linkages must operate without binding. On multiple section assemblies, blades must open and close simultaneously.
   6. Provide a visible and accessible indication of damper position on the drive shaft end.
   7. Support ductwork in area of damper when required to prevent sagging due to damper weight.
   8. After installation caulk between frame and duct and/or opening to prevent leakage around perimeter of damper.

B. Original Equipment Manufacturer Provided Controls. All OEM package DDC devices provided for this project shall completely comply with all of the requirements of this specification section.
   1. Provider of the OEM equipment/controls shall bear exactly the same burden of responsibility for products provided in other sections of this specification as the DDC System Contractor.
   2. A Protocol Implementation Conformance Statement (PICS) including a BACnet® Interoperability Building Block (BIBB) table shall be provided for any DDC device (hardware and software) provided to be integrated to the DDC system.

END OF SECTION
SECTION 232300

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS
A. Line Test Pressure for Refrigerant R-401A:

1.3 ACTION SUBMITTALS
A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and maintenance data.

1.6 QUALITY ASSURANCE
B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING
A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS
A. Copper Tube: ASTM B 88, Type L ACR (ASTM B 88M, Type A or B).
B. Wrought-Copper Fittings: ASME B16.22.
C. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
D. Brazing Filler Metals: AWS A5.8.

2.2 VALVES AND SPECIALTIES
A. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   4. End Connections: Copper spring.
B. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.

C. Straight-Type Strainers:
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
5. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.
C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION
3.1 PIPING APPLICATIONS
A. Hot-Gas and Liquid Lines, and Suction Lines:
   1. NPS 1-1/2 and Smaller: Copper, Type L ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS
Install thermostatic expansion valves as close as possible to distributors on evaporators.
1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
B. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Thermostatic expansion valves.

3.3 PIPING INSTALLATION
A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
B. Install refrigerant piping according to ASHRAE 15.
C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping adjacent to machines to allow service and maintenance.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Select system components with pressure rating equal to or greater than system operating pressure.
J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

M. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

N. When brazing or soldering, remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

O. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

P. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

Q. Install sleeves for piping penetrations of walls, ceilings, and nook. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less.
   2. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping, supported on a trapeze.
   3. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   2. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   3. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
C. Adjust set-point temperature of air-conditioning controllers to the system design temperature.
D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Verify that compressor oil level is correct.
   2. Open compressor suction and discharge valves.

END OF SECTION
SECTION 233113

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
1. Rectangular ducts and fittings.
2. Round ducts and fittings.
4. Sealants and gaskets.
5. Hangers and supports.
B. Related Sections:
1. Division 23 Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS
A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"
C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, and vibration isolation.
C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, for selecting hangers and supports.

1.4 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

B. Welding certificates.

1.5 QUALITY ASSURANCE
A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel," for hangers and supports. Welding Qualifications: Qualify procedures and personnel according to the following:

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ROUND DUCTS AND FITTINGS
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Lindab Inc.
      b. McGill AirFlow LLC.
      c. SEMCO Incorporated.
      d. Sheet Metal Connectors, Inc.
      e. Spiral Manufacturing Co., Inc.

B. Exposed flexible ductwork shall be painted grey. Color approved by architect.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2.3 SHEET METAL MATERIALS
A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.
C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

2.4 SEALANT AND GASKETS
A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg. positive and negative.
   8. Service: Indoor or outdoor.
C. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.
   6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
E. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS
A. Hanger Rods: Cadmium-plated steel rods and nuts.
B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
D. Trapeze and Riser Supports:

PART 3 - EXECUTION
3.1 DUCT INSTALLATION
A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
C. Install round ducts in maximum practical lengths.
D. Install ducts with fewest possible joints.
E. Install factory or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
H. Install ducts with a clearance of 1 inch plus allowance for insulation thickness.
I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers. Refer to the life safety plans provided by the architect for locations of the rated walls.
L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Seal all open ends of ducts and equipment air/watertight unless actively being installed.

3.2 DUCT SEALING
A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Exhaust, Outdoor, Return, Supply-Air Ducts: Seal Class A.

3.3 HANGER AND SUPPORT INSTALLATION
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
B. Building Attachments: Structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Do not use powder-actuated concrete fasteners.
C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
D. Hangers: Galvanized steel hanger straps 1-1/2" width.
E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets.
F. Install upper attachments to structures. Select and size upper attachments with appropriate for supported loads and building materials where used.

3.4 CONNECTIONS
A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 START UP
A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.6 DUCT SCHEDULE
A. Fabricate ducts with galvanized sheet steel except as otherwise indicated:
B. Supply Ducts:
   1. Ducts Connected to VAV or Constant Volume Air-Handling Units and duct mounted furnaces:
      a. Pressure Class: Positive or negative 3-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round: 6.
C. Exhaust Ducts:
   1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
      a. Pressure Class: Negative 2-inch wg.
      b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round: 6.

D. Intermediate Reinforcement:

E. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Velocity 1000 fpm or Lower:
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 with vanes.
   b. Velocity 1000 to 1500 fpm:
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm or Lower: 1.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.5 radius-to-diameter ratio and four segments for 90-degree elbow.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals;" and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION
SECTION 233300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   Manual volume dampers.
   1. Fire dampers.
   2. Flange connectors.
   3. Turning vanes.
   4. Duct-mounted access doors.
   5. Flexible connectors.
   6. Flexible ducts.
   7. Sound Attenuators.
   8. Duct accessory hardware.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      c. Motorized volume damper installations.
      d. Control damper installations.
      e. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
      f. Wiring Diagrams: For power, signal, and control wiring.
      g. Sound attenuators.
C. Performance Data: For Sound Attenuators
   1. Silencer manufacturer to provide submittal drawings detailing all duct silencer data specified in the mechanical drawing schedule.
   2. Submit laboratory acoustic and aerodynamic performance obtained according to ASTM E477-13 and so certified when submitted for approval. The laboratory must be currently NVLAP accredited for the ASTM E477-13 test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted. Shop drawings submitted without proper certifications will be rejected.
      a. Submitted silencer pressure drops shall not exceed those listed in the silencer schedule. Silencer pressure drop measurements shall be made in accordance with the ASTM E477-13 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.
      b. The manufacturer shall supply certified dynamic insertion loss and self-noise power level data for each scheduled silencer. The data shall match the project’s air distribution system requirement for forward or reverse flow, and total system airflow. All ASTM E477-13 tests to obtain this data shall be conducted in the same facility and shall utilize the same silencer.
      c. Silencer dynamic insertion loss shall not be less than that listed in the silencer schedule.
      d. Silencer generated noise shall not be greater than that listed in the silencer schedule.
   3. The silencer manufacturer shall provide, for approval, acoustical system calculations for all duct systems with silencers to demonstrate that the submitted silencers will reduce mechanical fan and air noise to NC___ in the occupied space. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as expressed in Table 34 of Chapter 47, “Sound and Vibration Control” of the 2003 ASHRAE Handbook - HVAC Applications, shall be used.
   4. The silencer manufacturer shall test the silencer(s) as indicated in the silencer schedule. The Engineer shall be notified of the test date at least two weeks in advance and the test may be witnessed by the Engineer. Test shall show compliance with the project criteria and is subject to
engineer approval. Test facilities and test reports shall be open to inspection upon request from the Engineer.

5. For specific silencers indicated on the silencer schedule, the silencer manufacturer shall provide Computational Fluid Dynamics (CFD) aerodynamic analysis. The analysis shall include the attached ductwork, a minimum of 5 equivalent duct diameters up and downstream of the silencer, as shown on the drawings, to determine silencer pressure drop, including system effects, at design airflow. The manufacturer must report and validate a converged solution domain of the CFD analysis to show the solution is independent of mesh refinement such that two models of different mesh refinement levels produce equivalent results, each with a maximum residual tolerance of 0.001. The minimum cell count shall be 200,000 and the validation model shall have a cell count at least 50% higher. The manufacturer must report the selection of CFD parameters, including mesh type, mesh size, boundary conditions, convergence criteria, and turbulence model. Each CFD analysis shall also include additional post-processed information including number of iterations, convergence status, and resulting y+ values.

D. Source quality-control reports:
1. Silencer manufacturer to provide a copy of their laboratory NVLAP accreditation certificate for the ASTM E477-13 test standard with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.

E. Submittals will be provided in the format indicated in the 2015 IECC paragraph C408.2.5.2 “Manuals”.

1.3 CLOSEOUT SUBMITTALS
A. Operation and maintenance data.

1.4 QUALITY ASSURANCE
B. Comply with AMCA 500-D testing for damper rating.
C. Silencer performance must have been substantiated by laboratory testing in a duct-to-reverberant room test facility according to ASTM E477-13. The test facility must provide for airflow in both directions through the test silencer. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption. The aero-acoustic laboratory must be currently NVLAP accredited for the ASTM E477-13 test standard.
D. Silencer manufacturer shall provide a written test report by a third party organization showing silencer assemblies have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
2. Exposed-Surface Finish: Mill phosphatized.
C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.2 MANUAL VOLUME DAMPERS
A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. McGill AirFlow LLC.
   b. METALAIRE, Inc.
   c. Nailor Industries Inc.
   d. Ruskin Company.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
a. Multiple or single blade.
b. Opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized-steel, 0.064 inch (1.62 mm) thick.

7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

2.3 FIRE DAMPERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. METALAIRE, Inc.
   3. Nailor Industries Inc.
   4. NCA Manufacturing, Inc.
   5. Pottorf; a division of PCI Industries, Inc.
   6. Ruskin Company.
B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
D. Fire Rating: 1-1/2 hours.
E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
G. Mounting Orientation: Vertical or horizontal as indicated.
H. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
J. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

2.4 FLANGE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Nexus PDQ; Division of Shilco Holdings Inc.
B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
C. Material: Galvanized steel.
D. Gage and Shape: Match connecting ductwork.

2.5 TURNING VANES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Inc.
   3. METALAIRE, Inc.
   4. SEMCO Incorporated.
B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
D. Vane Construction: Single wall.
E. Vane Construction: Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.
2.6 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Flexmaster U.S.A., Inc.
4. McGill AirFlow LLC.
5. Nailor Industries Inc.
6. Ventfabrics, Inc.


1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.


1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

2.8 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20 m/s).
3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

2.9 SOUND ATTENUATORS

A. Basis-of-Design Product: Silencers shall be Vibro-Acoustics.

1. Alternate manufacturers must request and obtain written approval by the Engineer to bid the project at least 10 days prior to the bid due-date. As a condition of pre-approval, alternate manufacturers must submit to the Engineer a minimum of twenty (20) different HVAC silencer test reports. Each report shall be for a silencer tested in full accordance with the ASTM E477-13 silencer test...
standard in an aero-acoustic test facility which is NVLAP accredited for the ASTM E477-13 standard. Each test shall have been conducted within the last 12 month period. A copy of the laboratory’s NVLAP accreditation certificate must be included with the submitted reports. Any changes to the specifications must be submitted and approved in writing by the Engineer at least 10 days prior to the bid due-date.

B. General Requirements:
1. Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on the drawings. All silencers shall be factory fabricated and supplied by the same manufacturer.
2. Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at silencers are not permitted unless shown on the contract drawings.
3. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in other sections are minimums. Material gauges shall be increased as required for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.
4. All casing seams and joints shall be lock-formed and sealed or stitch welded and sealed except as noted in Section G below, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.
5. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.
6. Fire-Performance Characteristics: Silencer assemblies, including acoustic media fill, Vibar™ film liner, sealants, and acoustical spacer, shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.

C. Rectangular Silencers including model RD:
Outer casing shall be ASTM A 653/A 653M, G90 galvanized sheet steel, 22 gauge.

1. Rectangular Silencers: 26 gauge.

E. Principal Sound-Absorbing Mechanism:
1. Dissipative and Film Lined silencers:
   a. Model RD, type with acoustic media. Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be resilient such that it will not crumble or break, and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

F. Media Protection:
   a. Dissipative silencers, including models RD: Where indicated on the silencer schedule, media shall be encapsulated in glass fiber cloth to help prevent shedding, erosion and impregnation of the glass fiber.

G. Accessories:
1. Access Doors: Where indicated on the silencer schedule, silencers shall be supplied with an access door(s. Access doors shall be supplied as an integral part of the silencer by the silencer manufacturer.
2. Shipping Protection: Silencers shall be shipped with factory-installed end caps to prevent contamination during shipping.

H. Source Quality Control: Test according to ASTM E 477-06a.
1. The manufacturer shall test the silencer(s) as indicated in the silencer schedule. The engineer shall be notified of the test date at least two weeks in advance and the test may be witnessed by the engineer. Test shall show compliance with the project criteria and is subject to engineer approval.
2. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance must have been substantiated by laboratory testing according to ASTM E477-13 and so certified when submitted for approval. The aero-acoustic laboratory must be NVLAP accredited for the ASTM E477-13 test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.

I. Capacities and Characteristics:
1. See duct silencer performance schedule on mechanical drawings.
2.10 DUCT ACCESSORY HARDWARE
A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install duct accessories according to applicable details in SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116.
B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts.
C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
D. Set dampers to fully open position before testing, adjusting, and balancing.
E. Install test holes at fan inlets and outlets and elsewhere as indicated.
F. Install fire dampers according to UL listing.
G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct furnaces
   2. Downstream from manual volume dampers, backdraft dampers, and equipment.
   3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links.
   4. Upstream and downstream from turning vanes.
   5. Control devices requiring inspection.
   6. Elsewhere as indicated.
H. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.
I. Install sound attenuators according to manufacturer's written installation instructions.
J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
K. Install flexible connectors to connect ducts to equipment.
L. Connect diffusers to ducts directly or with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
M. Connect flexible ducts to metal ducts with draw bands.
N. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL
A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Ensure duct silencers are installed with airflow arrows in direction of airflow

END OF SECTION
SECTION 233423

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Downblast Centrifugal roof ventilators.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method
         of field assembly, components, and location and size of each field connection.
      2. Wiring Diagrams: For power, signal, and control wiring.
      3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to
         structure and to supported equipment. Include adjustable motor bases, rails, and frames for
         equipment mounting.
   C. Submittals shall be provided in the format indicated in the 2015 IECC paragraph C408.2.5.2 “Manuals”.

1.3 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

1.4 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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-
      Certified Ratings Seal.

PART 2 - PRODUCTS

2.1 DOWNBLAST CENTRIFUGAL ROOF VENTILATORS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Aerovent; a division of Twin City Fan Companies, Ltd.
      2. Greenheck Fan Corporation.
      3. Loren Cook Company.
   B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with
      venturi inlet cone.
      1. Downblast Units: Provide spun-aluminum discharge baffle to direct discharge air downward.
   C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
   D. Direct Drive:
      1. Resiliently mounted to housing.
      2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   E. Accessories:
      1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
      2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing,
         factory wired through an internal aluminum conduit.
      3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
      4. Back Draft Dampers: Gravity backdraft dampers mounted in curb base to close when fan stops.
   F. Roof Curb:
      1. Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation
         adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
      2. Configuration: Built-in raised cant and mounting flange.
      3. Overall Height: Top of curb to be a minimum 12 inches above the surface of the roof. Contractor to
         coordinate the exact height to ensure sufficient height for flashing.
      4. Pitch Curb: Curb with sound-absorbing insulation.
      5. Metal Liner: Galvanized steel.
2.2 MOTORS
   A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency
      requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC
      Equipment."
      1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not
         require motor to operate in service factor range above 1.0.
      2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and
         connections specified in Division 26 Sections.
   B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL
   A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings
      from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for
      Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
   B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and
      efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic
      Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 Section "Roof
      Accessories" for installation of roof curbs.
   B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
   C. Install units with clearances for service and maintenance.
   D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and
      Equipment." Provide additional stick-on label on the ceiling grid next to the fan or on the exposed face of
      the fan to identify the fan from below the ceiling.

3.2 CONNECTIONS
   A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings
      indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible
      connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
   B. Install ducts adjacent to power ventilators to allow service and maintenance.
   C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL
   A. Perform 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.
      B. Tests and Inspections:
         1. Verify that shipping, blocking, and bracing are removed.
         2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and
            electrical components are complete. Verify that proper thermal-overload protection is installed in
            motors, starters, and disconnect switches.
         3. Verify that cleaning and adjusting are complete.
         4. Verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing
            operation.
         5. Adjust damper linkages for proper damper operation.
         6. Verify lubrication for bearings and other moving parts.
         7. Measure and record motor voltage and amperage.
         8. Remove and replace malfunctioning units and retest as specified above.
      C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      D. Prepare test and inspection reports.

3.4 ADJUSTING
   A. Adjust damper linkages for proper damper operation.
   B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing,
      adjusting, and balancing procedures.
C. Adjust fan speed controllers as required to achieve design airflow.
D. Lubricate bearings.

END OF SECTION
SECTION 233713
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Accutherm diffusers
4. Side Wall Diffusers
5. Eggcrate Return and Exhaust Grilles.
B. Related Sections:
1. Division 23 Section "Air Duct Accessories" for fire dampers and volume-control dampers not integral to diffusers, registers, and grilles.
C. Submittals to be provided in the format indicated in 2015 IECC paragraph C408.2.5.2 “Manuals”.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated, include the following:
1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
3. All air devices shall be provided by the same manufacturer.
B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS
A. Rectangular and Square Ceiling Diffusers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. METALAIRE, Inc.
   b. Nailor Industries Inc.
   c. Price Industries.
   d. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
4. Finish: Baked enamel, white
5. Face Size: 24 by 24 inches
7. Border: 1-1/2"
8. Mounting: T-bar or surface mount. Refer to the Air Distribution Schedule on the plans.
10. Dampers: None.
11. Accessories:
   a. Equalizing grid.

2.2 LINEAR SLOT DIFFUSER
A. Linear Slot Diffusers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. METALAIRE, Inc.
   b. Nailor Industries Inc.
   c. Price Industries.
   d. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
4. Finish: Standard white finish with black pattern controllers. For items installed in areas with no ceiling, paint black.
5. Length: 48 inches
6. Slot Width: 1.5"
7. Border: 1-1/2”
8. Mounting: T-bar or surface mount. Refer to the Air Distribution Schedule on the plans.
10. Dampers: None.
11. Accessories:
   a. Insulated plenum box.
   b. End caps.

2.3 GRILLES
Eggcrate Return and Exhaust Grilles:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Krueger.
   b. METALAIRE, Inc.
   c. Nailor Industries Inc.
   d. Price Industries.
   e. Titus.
3. Finish: Baked enamel, white.
4. Core Arrangement: Horizontal1/2 inch apart.
7. Mounting Frame: T-bar or surface mount. Refer to the Air Distribution Schedule on the plans.
8. Mounting: Countersunk screw for surface mounting.
9. Damper Type: Adjustable opposed blade for exhaust grilles in restrooms only. Damper must be operable from the face of the grille.
10. Accessories:
    a. Opposed bladed damper for exhaust grilles in the restrooms only.

2.4 ACCUTHERM DIFFUSERS
A. Accuthern Linear Thermafuse VAV Diffuser
1. Manufacturer: Therma-fuser
2. Model: TL-CW with individual set point for VAV Cooling and change over between heating and cooling modes based on supply and temperature.
3. Construction: Aluminum
4. Finish: White
5. Length: 48 or 60”
6. Slots: 2 slots / 1 way throw
7. Sensor: Room temperature with digital adjustor
8. Mounting frame: Refer to air distribution schedule
9. Inlet: Front, 8”

2.5 SOURCE QUALITY CONTROL
A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets.”

PART 3 - EXECUTION

3.1 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.

3.2 ADJUSTING
A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION
SECTION 234100

PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Pleated panel filters.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
   1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
   2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

1.3 CLOSEOUT SUBMITTALS
A. Operation and maintenance data.

1.4 QUALITY ASSURANCE
A. ASHRAE Compliance:
   1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
   2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.
B. Comply with NFPA 90A and NFPA 90B.
C. Minimum efficiency: MERV 13

PART 2 - PRODUCTS

2.1 PLEATED PANEL FILTERS
A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AAF International.
      b. Camfil Farr.
      c. Flanders-Precisionaire.
      d. Purafil, Inc.
B. Filter Unit Class: UL 900, Class 1.
C. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.
   1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
   3. Media shall be coated with an antimicrobial agent.
   4. Separators shall be bonded to the media to maintain pleat configuration.
   5. Welded wire grid shall be on downstream side to maintain pleat.
   6. Media shall be bonded to frame to prevent air bypass.
   7. Support members on upstream and downstream sides to maintain pleat spacing.
D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

2.2 INSTALLATION
A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
B. Install filters in position to prevent passage of unfiltered air.
C. Install filter gage for each filter bank.
D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
E. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling-unit installations.

2.3 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.

B. Tests and Inspections:
   1. Test for leakage of unfiltered air while system is operating.

C. Air filter will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

2.4 CLEANING
A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION
SECTION 237413
PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING 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.
   3. Hot-gas reheat.
   5. Economizer, minimum outdoor and return-air damper sections.
   6. Integral, space temperature controls.
   7. Roof curbs.

1.3 DEFINITIONS
A. DDC: Direct-digital controls.
B. ECM: Electrically commutated motor.
C. 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.
D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
E. 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.
F. 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.
G. 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.
H. VVT: Variable-air volume and temperature.

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design RTU supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Wind-Restraint Performance:
   1. Basic Wind Speed: 130 mph
   2. Building Classification Category: III.
   3. Minimum 10 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.5 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.
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.

D. Submit information in the format indicated in the 2015 IECC paragraph C408.2.5.2 “Manuals”.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which RTUs will be attached.
   2. Roof openings
   3. Roof curbs and flashing.

B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: Three (3) sets of filters for each unit.

1.9 QUALITY ASSURANCE

A. ARI Compliance:
   1. Comply with ARI 203/110 and ARI 303/110 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.

1.10 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 (5) years from date of Substantial Completion.
   2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three (3) years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide packaged roof top units (McQuay-Daikin) with electric cooling and natural gas fired heat, and economizer, dedicated outside air units (McQuay-Daikin) with electric cooling and natural gas fired heat and economizer or a comparable product by one of the following:
   1. McQuay International.
   2. Trane; American Standard Companies, Inc.
   3. Lennox
   4. Carrier

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.
D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   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 (50 mm) deep, and complying with ASHRAE 62.1.
   1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
   2. Drain Connections: Threaded nipple both sides of drain pan.
   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. Direct-Driven Supply-Air Fans: Single width, airfoil centrifugal; with permanently lubricated, ECM motor resiliently mounted in the fan inlet. 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. Relief-Air Fan: Propeller, shaft mounted on permanently lubricated motor.
D. 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 copper tube in steel casing with equalizing-type vertical distributor.
   2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
   3. Coil Split: Interlaced coil circuiting that keeps the full coil face active at all load conditions.
   4. Baked phenolic coating.
B. Hot-Gas Reheat Refrigerant Coil:
   1. Aluminum tube micro channel design.
   2. Fins shall be brazed to the tubing for direct bond.
   3. Capacity of reheat coil shall allow for, at minimum, 20°F temperature rise at all operating conditions.
   4. Baked phenolic coating.
2.5 **GAS FURNACE**
   A. Gas Furnace:
   1. 10-1 modulating heating control.
   2. 20 Gauge, G160 aluminized steel heat exchanger.
   3. In-shot gas burner.
   4. Flame roll out, high temperature limit switches.
   5. Induced draft fan with airflow safety switch.

2.6 **REFRIGERANT CIRCUIT COMPONENTS**
   A. Compressor: Inverter driven with modulating control scroll compressors mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
   B. Refrigeration Specialties:
      1. Refrigerant: R-410A
      2. Electronic expansion valve.
      3. Refrigerant filter/dryer.
      5. Automatic-reset low-pressure safety switch.
      8. Brass service valves installed in compressor suction and liquid lines.
      9. Low-ambient kit high-pressure sensor.
     10. Modulating hot-gas reheat valve with a replaceable magnetic coil.

2.7 **AIR FILTRATION**
   A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
      1. Prefilter: Pleated, 2" thickness, minimum 95 - 98 percent arrestance, and MERV 8.
      2. Final Filter: Pleated, 4" thickness, minimum 98 percent arrestance, and MERV 13.

2.8 **OUTDOOR AIR INTAKES**
   A. Economizer
      1. If only a single RTU is required for Project, retain one of two paragraphs and associated subparagraphs below. If Project includes multiple RTUs, retain both paragraphs and indicate which unit gets each component in a schedule. First paragraph is for limited outdoor air; second is for units with economizer controls. ASHRAE/IESNA 90.1 sets requirements for dampers. Retain second option in first paragraph below to comply with requirements in ASHRAE/IESNA 90.1 which may be required if applying for LEED certification, by Project requirements, or authorities having jurisdiction.
      2. Outdoor-Air Damper: Linked damper blades (opposed blade construction), for 0 to 100 percent outdoor air, with motorized damper and filter.
      3. Outdoor air hood with moisture eliminator.
      4. Economizer control integrated in to the unit controller with spring return damper actuators, adjustable minimum OA setpoint and changeover controls.
      5. Economizer controller to be a comparative enthalpy controller with OA temperature and R/Sensors and RA temperature and RH sensors.
      6. Outdoor- Air and Return-Air Mixing Dampers: 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.
         a. Damper Motor: Modulating with adjustable minimum position.
         b. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.
   B. Minimum outdoor air damper:
      1. Outdoor Air Damper: Linked damper blades (opposed blade construction) sized to maintain a velocity of 1500 FPM across the damper at minimum flow (OCV mode). Provide without N.C. Spring return motionized damper, Airflow monitor (Ebron Gold) and outdoor air filter.
      2. Outdoor air intake hood with moisture eliminator.

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. Control equipment and sequence of operation are specified in Section 230900 “Instrumentation and
Control for HVAC.”
B. Basic Unit Controls:
1. Control-voltage transformer.
2. Wall-mounted thermostat or sensor with the following features:
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. Exposed set point.
   g. Exposed indication.
   h. Degree F indication.
   i. Unoccupied-period-override push button.
   j. Data entry and access port to input temperature and humidity set points, occupied and
      unoccupied periods, and output room temperature and humidity, supply-air temperature,
      operating mode, and status.
   k. Interface to base building BAS System
3. Wall-mounted humidistat or sensor with the following features:
   a. Exposed set point.
   b. Exposed indication.
   c. Interface to Base building BAS System.
4. 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.
5. Wall mounted CO2 sensor
   a. Wall Mounted
   b. Range: 0-2000 PPM
   c. LCD Display
   d. Interface to base building BAS System
C. DDC Controller:
1. Controller shall have volatile-memory backup.
2. Safety Control Operation:
   a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide
      additional contacts for alarm interface to fire alarm control panel.
   b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F 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” Retain
      subparagraph below for low-ambient feature.
   d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air
      temperature is less than 40 deg F.
   e. Gas furnace high limit: De-energize gas furnace.
3. Scheduled Operation: Occupied and unoccupied periods on seven, 365-day clock with a minimum
   of four programmable periods per day.
4. Unoccupied Period:
   a. Rooftop package units - Heating Setback: Set un-occupied heating temperature to 55 deg
      F.
   b. Rooftop package units - Cooling Setback: Set un-occupied cooling temperature to 78 deg F.
   c. Rooftop package units - Override Operation: Two hours.
   d. Outdoor air damper position: closed
   e. Return air damper position open
5. Supply Fan Operation:
   a. Occupied Periods: Run fan continuously.
   b. Unoccupied Periods: Cycle rooftop package unit fans to maintain setback temperature.
6. Refrigerant Circuit Operation:
a. Occupied Periods: Cycle, stage and modulate compressors, and operate hot-gas reheat to match compressor output to cooling load to maintain room temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.

b. Unoccupied Periods: Cycle compressors and condenser fans to maintain the cooling setback temperature.

c. During a call for dehumidification, the refrigeration system is energized to maintain the space RH setpoint. This can occur during the occupied or un-occupied periods.

7. Hot-Gas Reheat-Coil Operation:
   a. Occupied Periods – Call for dehumidification: Thermostat opens hot-gas valve to provide hot-gas reheat to maintain the space temperature setpoint during dehumidification sequence.
   b. Unoccupied Periods – Call for dehumidification: Thermostat opens hot-gas valve to provide hot-gas reheat to maintain the space temperature setpoint during dehumidification sequence.

8. Gas Fired Furnace Operation:
   a. Occupied Periods: Cycle the furnace to maintain room temperature.
   b. Unoccupied Periods: Cycle the furnace to maintain setback temperature.

9. Minimum Outdoor-Air Damper Operation:
   a. Occupied Periods: Open to maintain the minimum OA cfm setpoint.
   b. Unoccupied Periods: Close the outdoor-air damper.

10. Economizer Outdoor-Air Damper Operation:
    a. Occupied Periods: If enthalpy conditions are favorable for economizer operation (outdoor air enthalpy is lower than return air enthalpy), modulate the outdoor air toward open and the return air damper towards closed to lower the mixed air temperature. The mechanical cooling operates as needed to maintain the discharge air temperature. The relief fan cfm tracks the outdoor airflow cfm to maintain the building space pressure setpoint. If the outdoor air is able to meet the discharge air temperature setpoint, the mechanical cooling is de-energized. When the outdoor air damper is fully open and the return air damper is fully closed and the outdoor air cannot meet the discharge air temperature setpoint, the unit is taken out of economizer. The OA damper returns to the design minimum OA cfm and the mechanical cooling is re-energized. The gas fired heater is de-energized during the economizer cycle. If the space R/H exceeds the space R/H or return air R/H sensor setpoints during the economizer cycle, the unit switches to the dehumidification mode. The OA damper returns to the minimum OA cfm mode, the return air damper modulates toward open and the mechanical cooling is energized.
    b. Unoccupied Periods (cooling, heating, dehumidification, modes): The OA damper remains closed during un-occupied periods, the return air damper remains open and the relief damper is closed.
    c. Unoccupied periods (economizer mode): If the system calls for cooling during the un-occupied mode and outdoor enthalpy is more favorable than return air enthalpy then the unit operates in the same mannerisms during the occupied mode.
    d. 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 2- to 10-V dc.

11. Carbon Dioxide Sensor Operation:
    a. Occupied Periods: Open the OA damper to provide the design minimum OA cfm to maintain the space CO2 below 1100-ppm concentration. If the space CO2 exceeds 1100 ppm concentration gradually open the damper to the ventilation OA cfm setpoint. When the space CO2 returns to below 1100 ppm concentration gradually close the OA damper to the minimum OA cfm position.
    b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

D. Interface Requirements for HVAC Instrumentation and Control System:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
   3. Provide BACnet compatible interface for central HVAC control workstation for the following:
      a. Adjusting set points.
      b. Monitoring supply fan start, stop, and operation.
      c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
      d. Monitoring occupied and unoccupied operations.
      e. Monitoring constant and variable motor loads.
f. Monitoring variable-frequency drive operation.
g. Monitoring cooling load.
h. Monitoring economizer cycles.
i. Monitoring air-distribution static pressure and ventilation air volume.
j. Adjusting operating schedules
k. Monitoring alarms

2.11 ACCESSORIES
A. Low-ambient kit using variable-speed condenser fans for operation down to 35 deg F.
B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
C. Coil guards of painted, galvanized-steel wire.
D. Hail guards of galvanized steel, painted to match casing.

2.12 ROOF CURBS
A. Roof curbs with vibration isolators and wind restraints.
B. 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: 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.
C. Curb Height: The curb height is to be determined by the contractor to ensure the top of the curb is a minimum of 18" above the roof to allow for adequate flashing of the roof curb.
D. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site.

2.13 CAPACITIES AND CHARACTERISTICS
A. Supply-Air Fan:
   1. Airflow: Reference schedule
   2. External Static Pressure: Reference schedule
   3. Fan Speed: Reference schedule
   4. Motor Horsepower: Reference schedule
   5. Motor Speed: Reference schedule
B. Relief-Air Fan:
   1. Airflow: Reference schedule
   2. External Static Pressure: Reference schedule
   3. Fan Speed: Reference schedule
   4. Motor Horsepower: Reference schedule
   5. Motor Speed: Reference schedule
C. Supply-Air Refrigerant Coil:
   1. Total Cooling Capacity: Reference schedule
   2. Sensible Cooling Capacity: Reference schedule
   3. Entering-Air Dry-Bulb Temperature: Reference schedule
   4. Entering-Air Wet-Bulb Temperature: Reference schedule
D. Hot-Gas Reheat Coil:
   1. Heating Capacity: Reference schedule
   2. Entering-Air Temperature: Reference schedule
   3. Air-Temperature Rise: Reference schedule
E. Natural Gas Furnace:
   1. Capacity: Reference schedule
   2. Number of Steps: Reference schedule
   3. Air Temperature Rise: Reference schedule
F. Compressors:
1. Seasonal Energy-Efficiency Ratio (SEER): Reference schedule
2. Coefficient of Performance (COP): Reference schedule

G. Air Filters:
1. Minimum Face Area: Reference schedule
2. Thickness: Reference schedule
3. MERV Rating: Reference schedule

H. Electrical Characteristics for Single-Point Connection:
1. Voltage: Reference schedule
2. Phase: Reference schedule
3. Hertz: Reference schedule
5. Minimum Circuit Ampacity: Reference schedule
6. Maximum Overcurrent Protection: Reference schedule

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. Equipment Mounting:
1. Install units on roof.
B. Roof Curb: Install on roof structure level and secure. 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 with anchor bolts.
C. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
D. Provide permanent labels for Section 230553 Identification of HVAC Equipment.

3.3 CONNECTIONS
A. Install condensate drain, minimum connection size at least the size of the unit connection, with trap and indirect connection to nearest roof drain or area drain.
B. Install piping adjacent to RTUs to allow service and maintenance.
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.

3.4 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
B. 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.
C. Tests and Inspections:
   1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. 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.
   d. Verify economizer operation.
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.
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 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:
   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 (2) 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 238126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
C. Submit information in the format indicated in the 2015 IECC paragraph C408.2.5.2 “Manuals”.

1.3 INFORMATIONAL SUBMITTALS
A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS
A. Operation and maintenance data.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE Compliance:
   2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - “Outdoor Air Quality,” Section 5 - “Systems and Equipment,” Section 6 - “Procedures,” and Section 7 - “Construction and System Start-up.”
C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.6 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period:
      a. For Compressor: Ten year(s) from date of Substantial Completion.
      b. For Parts: Ten year(s) from date of Substantial Completion.
      c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Trane
   2. Lennox International Inc.
   3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
   4. SANYO North America Corporation; SANYO Fisher Company.
   5. LG, Life’s Good.
2.2 INDOOR WALL MOUNTED UNITS (2 TONS AND LESS)
General: Indoor unit shall be a wall mounted fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor units sound pressure shall range from 31 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and from the unit.

A. Indoor Unit:
1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through a resin net mold resistant filter.
5. The indoor units shall be equipped with a condensate pan.
6. The indoor units shall be equipped with a return air thermistor.
7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
8. The voltage range will be 253 volts maximum and 187 volts minimum.

B. Unit Cabinet:
1. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

C. Fan:
1. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.054 to 0.058 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

D. Coil:
1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 14 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 11/16 inch outside diameter PVC.
5. A thermistor will be located on the liquid and gas line.
6. A condensate pan shall be located in the unit.

E. Electrical:
1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

H. Controls:
1. The unit shall have controls provided by equipment manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
3. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller or approved equal.

2.3 CONDENSING UNITS (2 TONS OR LESS)
The variable capacity, air conditioning system shall be a Variable Refrigerant Volume Series (heat/cool model) split system. The system shall consist of a single evaporator and an outdoor condensing unit using PID control. The outdoor units shall be a nominal 2 ton, direct expansion (DX), air-cooled air-conditioning system, inverter driven variable speed compressor, single zone split system, using R-410A refrigerant. The outdoor unit may connect an indoor evaporator capacity up to 130% to that of the outdoor condensing unit capacity. The indoor units shall be connected to the condensing unit. Operation of the system shall permit cooling of the indoor unit. The indoor unit shall be able to provide set temperature independently via a local remote controller, an Intelligent Touch Controller, an Intelligent Manager or a BMS interface. Each indoor unit shall be independently controlled.

General:
1. Voltage Platform – Heat pump condensing units shall be available in 208-230V/1/60 configurations.
2. Advanced Zoning – A single system shall provide for up to 8 zones.
3. Independent Control – Each indoor unit shall use a dedicated electronic expansion valve for independent control.
4. VFD Inverter Control – Each condensing unit shall use a high efficiency, variable speed “inverter” compressor coupled with inverter fan motors for superior part load performance. Compressor capacity shall be modulated automatically to maintain a constant suction pressure, while varying the refrigerant volume for the needs of the cooling or heating loads. Indoor units shall use PID control to control superheat to deliver a comfortable room temperature condition.
5. Flexible Design –
a) Systems shall be capable of up to 492ft (575ft equivalent) of linear piping between the condensing unit and furthest located indoor unit.
b) Systems shall be capable of up to 1,000ft total “one-way” piping in the piping network.
c) Systems shall have a vertical (height) separation of up to 164ft between the condensing unit and the indoor unit units.
d) The outdoor unit shall connect an indoor evaporator capacity up to 130% of the outdoor condensing unit capacity.
7. Outside Air – Systems shall provide outside air integration capability.
8. Space Saving – Each system shall have a condensing unit module footprint of 52-15/16” x 35-7/16” x 12-5/8”.
9. Advanced Diagnostics – Systems shall include a self diagnostic, auto-check function to detect a malfunction and display the type and location.
10. Advanced Controls – Each system shall have at least one remote controller capable of controlling up to 16 indoor unit units. Each system shall be capable of integrating with open protocol BACnet and LonWorks building management systems.
11. Low Sound Levels – Each system shall use indoor and outdoor units with quiet operation as low as 28 dB(A).

A. Condensing Unit:
1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a Daikin scroll compressor, motors, fans, condenser coil, electronic expansion valves, solenoid valves, distribution headers, capillaries, filters, shut off valves, oil separator, service ports and suction line accumulator. Liquid and suction lines must be individually insulated between the outdoor and indoor units.
2. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
3. The connection ratio of indoor units to outdoor unit shall be permitted up to 130%.
4. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
5. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
6. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
7. The following safety devices shall be included on the condensing unit; high pressure switch, low pressure switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
8. To ensure the liquid refrigerant does not flash when supplying to the indoor unit, the circuit shall be provided with a sub-cooling feature.
9. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
10. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.

B. Unit Cabinet:
1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:
1. The condensing unit shall consist of two propeller type, direct-drive 70 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The fan shall be a horizontal discharge configuration with a nominal airflow maximum range of 3,740 CFM.
3. Nominal sound pressure levels shall be as shown below.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
6. The outdoor unit shall be capable of operating at further reduced sound levels during night time.

D. Condenser Coil:
1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

E. Compressor:
1. The inverter scroll compressor shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll "G-type" with a maximum speed of 6,480 rpm.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be 24% to 100%.
5. The compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
6. Oil separators shall be standard with the equipment together with an intelligent oil management system.
7. The compressor shall be spring mounted to avoid the transmission of vibration.

F. Electrical:
1. The power supply to the outdoor unit shall be 208/230 volts, 1 phase, 60 hertz +/- 10%.
2. The control voltage between the indoor and outdoor unit shall be 18VDC non-shielded, stranded 2 conductor cable.
3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.

4. The control wiring type shall be 18 AWG, 2 wire, non-polarity, non shielded, stranded.

G. Refrigerant Piping:
The system shall be capable of refrigerant piping up to 492 actual feet or 575 equivalent feet from the outdoor unit to the furthest indoor unit, a total combined liquid line length of 1,000 feet of piping between the condensing and indoor unit units with 164 feet maximum vertical difference, without any oil traps. REFNET™ (or approved equal) piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

2.4 ACCESSORIES
A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
   4. Fan-speed selection including auto setting.
D. Automatic-reset timer to prevent rapid cycling of compressor.
E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
F. Drain Hose: For condensate.
G. Additional Monitoring:
   1. Monitor constant and variable motor loads.
   3. Monitor economizer cycle.
   4. Monitor cooling load.
   5. Monitor air distribution static pressure and ventilation air volumes.
   6. Tie alarm into building management system.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install units level and plumb.
B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
C. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts" Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

3.3 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.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION
SECTION 260010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 GENERAL
A. Basic Requirements: The Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
B. General Provisions: Provide all labor, materials, equipment, and incidentals required to make ready for use complete electrical systems as specified herein and shown on the drawings.
C. Provide and Install: The word “provide” where used on the Drawings or in the Specifications shall mean “furnish, install, mount, connect, test, complete, and make ready for operation”. The word “install” where used on the Drawings or in the Specifications shall mean “mount, connect, test, complete, and make ready for operation”. Perform work required by, and in accordance with, the Contract Documents.
D. Installation: Provide and place in satisfactory condition, ready for proper operation, raceways, wires, cables, and other material needed for all complete electrical systems required by the Contract Documents. Additional raceways and wiring shall be provided to complete the installation of the specific equipment provided. Include auxiliaries and accessories for complete and properly operating systems. Provide electrical systems and accessories to comply with the NEC, state and local codes and ordinances. It is the intent of these Specifications that the electrical systems be suitable in every way for the use intended. Material and work which is incidental to the work of this Contract shall be provided at no additional cost to the Contract.
E. Field Connections: Provide field connections to remote equipment and control panels provided under other Divisions of these Specifications. Provide raceway, wire, and interconnections between equipment, transmitters, local indicators, and receivers. Provide 120V and low voltage surge protection equipment in accordance with Section 264313 at equipment as required. Install field connections to "packaged" equipment provided under other Divisions of these Specifications.

1.02 SCOPE OF WORK
A. General: Provide labor, materials, permits, inspections and re-inspection fees, tools, equipment, transportation, insurance, temporary protection, temporary power and lighting, supervision and incidental items essential for proper installation and operation of the Electrical systems indicated in the Contract Documents. Provide materials not specifically mentioned or indicated but which are usually provided or are essential for proper installation and operation of the Electrical systems indicated in the contract documents.
B. Notices: Give notices, file Plans, pay fees, and obtain permits and approvals from authorities having jurisdiction. Include all fees in the Bid Price.

1.03 INTERPRETATION OF DRAWINGS
A. General: The Drawings are diagrammatic and are not intended to show exact locations of Raceway runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, Raceways, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be determined and coordinated in the field. The right is reserved to change, without additional cost, the location of any outlet within the same room or general area before it is permanently installed. Obtain all information relevant to the placing of electrical work and in case of interference with other work, proceed as directed by the Architect.
B. Discrepancies: Notify the Architect of any discrepancies found during construction of the project. The Architect will provide written instructions as to how to proceed with that portion of work. If a conflict exists between the Contract Documents and an applicable code or standard, the most stringent requirement shall apply.
C. Wiring: Each three-phase circuit shall be run in a separate Raceway unless otherwise shown on the Drawings. Unless otherwise accepted by the Architect, Raceway shall not be installed exposed. Where circuits are shown as "home-runs" all necessary fittings, supports, and boxes shall be provided for a complete raceway installation.
D. Layout: Circuit layouts are not intended to show the number of fittings, or other installation details. Connections to equipment shall be made as required, and in accordance with the accepted shop and manufacturer's setting drawings.
E. Coordination: Coordinate final equipment locations with drawings or other disciplines. Layout before installation so that all trades may install equipment in available space. Provide coordination as required for installation in a neat and workmanlike manner.
1.04 EQUIPMENT SIZE AND HANDLING
A. Coordination: Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, ship the equipment in sections of specific sizes to permit the passing through the necessary areas within the structure.
B. Handling: Equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

1.05 RECORD DRAWINGS
A. Production: The Contractor shall provide two (2) sets of black or blue line on white drawings to maintain and submit record "As-Built Documents". Label each sheet of the Record Document set with “Project Record Documents” with company name of the installing contractor in stamped or printed letters. One set shall be maintained at the site and at all times be accurate, clear, and complete. These drawings shall be available at all times to the Architect's field representatives.
B. Recording: Record information concurrent with construction progress. Make entries within 24 hours upon receipt of information. The "As-Built" drawings shall accurately reflect installed electrical work specified or shown on the Contract Documents.
C. Completion: At the completion of the Work, transfer changes with a colored pencil onto the second set and submit to the Architect. The "As-Built" drawings shall be made available to the Architect to make the substantial completion punch list.
D. Final: Upon Contractor’s completion of the Engineer’s final punch list, transfer all “As-Built” conditions and all requirements by the Engineer to a reproducible set of drawings and CAD files. Submit drawings and CAD disks for review and acceptance. The Contractor shall provide updated disks which include final As-Built conditions.

1.06 ABBREVIATIONS
A. Abbreviations: The following abbreviations or initials may be used:
   - A/C: Air Conditioning
   - AC: Alternating Current
   - ABV CLG: Above Ceiling
   - ADA: Americans with Disabilities Act
   - AF: Ampere Frame
   - AFF: Above Finished Floor
   - AFG: Above Finished Grade
   - AHU: Air Handler Unit
   - AIC: Amps Interrupting Capacity
   - AL: Aluminum
   - AMP: Ampere
   - ANSI: American National Standards Institute
   - ASA: American Standards Association
   - AT: Ampere Trip
   - ATS: Automatic Transfer Switch
   - AUX: Auxiliary
   - AWG: American Wire Gauge
   - BC: Bare Copper
   - BIL: Basic Impulse Level
   - BMS: Building Management System
   - BRKR or BKR: Breaker
   - CAB: Cabinet
   - C: Conduit or Raceway
   - CB: Circuit Breaker
   - CBM: Certified Ballast Manufacturers
   - CCTV: Closed Circuit Television
   - CKT: Circuit
   - CLEC: Clock Equipment Cabinet
   - CLG: Ceiling
   - CO: Conduit or Raceway Only
   - COAX: Coaxial Cable
   - COND: Conductor
   - CONN: Connection
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
</tr>
<tr>
<td>CRT</td>
<td>Cathode Ray Terminal (Video display terminal)</td>
</tr>
<tr>
<td>CT</td>
<td>Current Transformer</td>
</tr>
<tr>
<td>CU</td>
<td>Copper</td>
</tr>
<tr>
<td>CW</td>
<td>Cold Water</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Current</td>
</tr>
<tr>
<td>DDC</td>
<td>Direct Digital Control</td>
</tr>
<tr>
<td>DEG</td>
<td>Degree</td>
</tr>
<tr>
<td>DISC</td>
<td>Disconnect</td>
</tr>
<tr>
<td>DO</td>
<td>Draw Out</td>
</tr>
<tr>
<td>DN</td>
<td>Down</td>
</tr>
<tr>
<td>DPST</td>
<td>Double Pole Single Throw</td>
</tr>
<tr>
<td>EMT</td>
<td>Electrical Metallic Tubing</td>
</tr>
<tr>
<td>EO</td>
<td>Electrically Operated</td>
</tr>
<tr>
<td>EOL</td>
<td>End of Line Resistor</td>
</tr>
<tr>
<td>EWC</td>
<td>Electric Water Cooler</td>
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<tr>
<td>FAAP</td>
<td>Fire Alarm Annunciator Panel</td>
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<tr>
<td>FACP</td>
<td>Fire Alarm Control Panel</td>
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<tr>
<td>FCU</td>
<td>Fan Coil Unit</td>
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<tr>
<td>FLA</td>
<td>Full Load Amperes</td>
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<tr>
<td>FM</td>
<td>Factory Mutual</td>
</tr>
<tr>
<td>GF</td>
<td>Ground Fault</td>
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<tr>
<td>GFCI</td>
<td>Ground Fault Circuits Interrupter</td>
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<tr>
<td>GND</td>
<td>Ground</td>
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<tr>
<td>HOA</td>
<td>Hand-Off-Automatic</td>
</tr>
<tr>
<td>HORIZ</td>
<td>Horizontal</td>
</tr>
<tr>
<td>HP</td>
<td>Horsepower</td>
</tr>
<tr>
<td>IC</td>
<td>Intercom</td>
</tr>
<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
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<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronic Engineers</td>
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<tr>
<td>IES</td>
<td>Illuminating Engineering Society</td>
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<tr>
<td>IMC</td>
<td>Intermediate Metallic Raceway</td>
</tr>
<tr>
<td>IN</td>
<td>Inches</td>
</tr>
<tr>
<td>IT</td>
<td>Instantaneous Trip</td>
</tr>
<tr>
<td>IPCEA</td>
<td>Insulated Power Cable Engineers Association</td>
</tr>
<tr>
<td>JB</td>
<td>Junction Box</td>
</tr>
<tr>
<td>KCMIL</td>
<td>Thousand Circular Mills</td>
</tr>
<tr>
<td>KV</td>
<td>Kilovolt</td>
</tr>
<tr>
<td>KVA</td>
<td>Kilo-Volt-Amps</td>
</tr>
<tr>
<td>KW</td>
<td>Kilowatts</td>
</tr>
<tr>
<td>LBS</td>
<td>Pounds</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
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<tr>
<td>LT</td>
<td>Light</td>
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<tr>
<td>LTD</td>
<td>Long Time Delay</td>
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<td>LTT</td>
<td>Long Time Trip</td>
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<tr>
<td>LTG</td>
<td>Lighting</td>
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<tr>
<td>MAX</td>
<td>Maximum</td>
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<tr>
<td>MCB</td>
<td>Main Circuit Breaker</td>
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<tr>
<td>MCC</td>
<td>Motor Control Center</td>
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<tr>
<td>MCP</td>
<td>Motor Circuit Protector</td>
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<tr>
<td>MIC</td>
<td>Microphone</td>
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<tr>
<td>MIN</td>
<td>Minimum</td>
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<tr>
<td>MLO</td>
<td>Main Lugs Only</td>
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<tr>
<td>MTD</td>
<td>Mounted</td>
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<tr>
<td>MTG</td>
<td>Mounting</td>
</tr>
<tr>
<td>MUX</td>
<td>Multiplex (Transponder) Panel</td>
</tr>
<tr>
<td>MVA</td>
<td>Mega Volt Amps</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>NC</td>
<td>Normally Closed</td>
</tr>
<tr>
<td>NEC</td>
<td>National Electrical Code</td>
</tr>
<tr>
<td>NECA</td>
<td>National Electrical Contractors Association</td>
</tr>
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</table>

BASIC ELECTRICAL REQUIREMENTS
260010 - 3
1.07 CODES, FEES, AND STANDARDS

A. Application: The codes, standards and practices listed herein generally apply to the entire project and specification sections. Other codes, standards or practices that are more specific will be referenced within a particular specification.

B. Requirements: All materials and types of construction covered in the specifications will be required to meet or exceed applicable standards of manufacturer, testing, performance, and installation according to the requirements of UL, ANSI, NEMA, IEEE, and NEC referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents that exceed but are not contrary to governing codes shall be followed.
C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed electrical installation shall be inspected and certified by applicable agencies that it is in compliance with codes.

D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements.
   1. State of Texas.
   2. Brazos County.
   3. City of College Station.

E. Utility Company: Comply with latest utility company regulations.

F. Standards: American Society of Mechanical Engineers

G. Labels: Materials and equipment shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available or desired for certain types of equipment, test data shall be submitted to validate that equipment meets or exceeds available standards.

H. International Building Code 2015: Conform in strict compliance to the International Building Code (IBC) and the amendments which are enforced by the local authority having jurisdiction.
   1. International Building Code – Mechanical 2015

I. NFPA: National Fire Protection Association (NFPA) Standards

1.08 INVESTIGATION OF SITE
A. General: Before commencing work, verify existing conditions at the premises including, but not limited to, existing structural frame, existing openings; existing wall and partition locations, existing mechanical and electrical work, equipment type, and examine adjoining work on which work is in anyway dependent.

B. Responsibility: No waiver of responsibility for defective and inadequate work or additional cost as a result of existing conditions which should have been verified shall be considered unless notice of same has been filed by the Contractor and agreed to in writing by the Architect before the bid date.

1.09 SUPERVISION OF THE WORK
A. Supervision: Provide one field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable sizes, type and complexity. The Superintendent shall be present at all times when work is being performed. At least one member of the Electrical Contracting Firm shall hold a State Master Certificate of Competency.

1.10 COORDINATION
A. General: Compare drawings and specifications with those of other trades and report any discrepancies between them to the Architect. Obtain from the Architect written instructions to make the necessary changes in any of the affected work. Work shall be installed in cooperation with other Trades installing interrelated work. Before installation, Trades shall make proper provisions to avoid interferences in a manner approved by the Architect.

B. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for:
   1. Architectural Reflected Ceiling Plan
   2. Door hardware
   3. Roll-up doors
   4. Roll-up grilles
   5. Signage
6. Fire shutters
7. Sliding or automatic doors
8. Mechanical Division of the Specifications
9. Landscape Architect drawings
10. Kitchen equipment
11. Interior design drawings
12. Fountains
13. Millwork design drawings and shop drawings

C. Obtain set of Contract Documents from Owner’s Authorized Representative or Contractor for all areas of work noted above and include all electrical work in bid whether included in Division 26 Contract Documents or not.

D. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed.

E. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner.

F. Adjustments: Locations of raceway and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of systems prior to fabrication or installation.

G. Priorities: Lines which pitch shall have the right of way over those which do not pitch. For example, plumbing drains shall normally have the right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.

H. Modifications: Offsets and changes of direction in raceway systems shall be made to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. Provide elbows, boxes, etc., as required to allow offsets and changes to suit job conditions.

I. Replacement: Work shall be installed in a way to permit removal (without damage to other parts) of other system components provided under this Contract requiring periodic replacement or maintenance. Raceway shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.

J. Layout: The Contract Drawings are diagrammatic only intending to show general runs and locations of raceway and equipment, and not necessarily showing required offsets, details and accessories and equipment to be connected. Work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation, which will afford maximum accessibility for operation, maintenance and headroom.

K. Contract Conflicts: Where discrepancies exist in the Scope of Work as to what Trade provides items such as starters, disconnects, flow switches, etc. such conflicts shall be coordinated between the divisions involved. It is the intent of the Contract Documents that all work shall be provided complete as one bid price.

L. Drawing Conflicts: Where drawing details, plans or specification requirements are in conflict and where sizes of the same item run are shown to be different within the contract documents, the most stringent requirement shall be included in the Contract. Systems and equipment called for in the specification or as shown on the drawings shall be provided as if it was required by both the drawings and specifications. Prior to ordering or installation of any portion of work, which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.

M. It is the responsibility of this Contractor to coordinate the exact required location of floor outlets, floor ducts, floor stub-ups, etc. with Owner’s Authorized Representative and Designer (and receive their approval) prior to rough-in. Locations indicated in Contract Documents are only approximate locations.

N. The Contract Documents describe specific sizes of switches, breakers, fuses, Raceways, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Coordinate the requirements of each load with each load’s respective circuitry shown and with each load’s requirements as noted on its nameplate data and manufacturer’s published electrical criteria. Adjust circuit breaker, fuse, Raceway, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes shall be made at no additional cost to the Owner.

O. Working Clearances: Minimum working clearances about electrical equipment shall be as referenced in the applicable edition NEC Article 110, and shall include equipment installed in ceiling spaces.

PART 2 - PRODUCTS
2.01 MATERIALS
A. Specified Method: Where several brand names, make or manufacturers are listed as acceptable each shall be regarded as equally acceptable, based on the design selection but each must meet all specification requirements. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance. No substitutions are permitted.

B. Certification: When a product is specified to be in accordance with a trade association or government standard requested by the Engineer, Contractor shall provide a certificate that the product complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.

C. Basis of Bid: Each bidder represents that his bid is based upon the manufacturer's materials and equipment described in the Contract Documents.

D. Space Requirements: Equipment or optional equipment shall conform to established space requirements within the project. Equipment which does not meet space requirements, shall be replaced at no additional expense to the Contract. Modifications of related systems shall be made at no additional expense to the Contract. Submit modifications to the Architect/Engineer for acceptance.

2.02 SHOP DRAWINGS
A. General: Shop drawings shall be submitted for every item listed within the Submittals section each individual specification section. One copy shall be submitted to the engineer prior to ordering equipment. Refer to Basis of approval paragraph.

B. Responsibility: It is the Contractor's responsibility to provide material in accordance with the plans and specifications. Material not provided in accordance with the plans and specifications shall be removed and replaced at the Contractor's expense.

C. Official Record: The shop drawing submittal shall become the official record of the materials to be installed. If materials are installed which do not correspond to the record submittal they shall be removed from the project without any additional cost or delays in construction completion.

D. Information: The shop drawing record submittal shall include the following information to the extent applicable to the particular item;
   1. Manufacturer's name and product designation or catalog number.
   2. Standards or specifications of ANSI, ASTM, ICEA, IEEE, ISA, NEMA, NFPA, OSHA, UL, or other organizations, including the type, size, or other designation.
   3. Dimensioned plan, sections, and elevations showing means for mounting, raceway connections, and grounding, and showing layout of components.
   4. Materials and finish specifications, including paints.
   5. List of components including manufacturer's names and catalog numbers.
   6. Internal wiring diagram indicating connections to components and the terminals for external connections.
   7. Manufacturer's instructions and recommendations for installation, operation, and maintenance.
   8. Manufacturer's recommended list of spare parts.
   9. Provide 1/2" = 1'-0" enlarged electrical room layout drawings for all electrical rooms. All equipment shall be indicated at actual size of equipment being provided. All dimensions and required working clearances shall be shown.

E. Preparation: Prior to submittal, shop drawings shall be checked for accuracy and contract requirements. Shop drawings shall bear the date checked and shall be accompanied by a statement that the shop drawings have been examined for conformity to Specifications and Drawings. This statement shall also list discrepancies with the Specifications and Drawings. Shop drawings not so checked and noted shall be returned to Contractor unreviewed.

F. Basis of Review: Approval is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Contractor is responsible for quantities, dimensions, fabrication processes, and construction techniques.

G. Responsibility: The responsibility that dimensions are confirmed and correlated with proper coordination of other trades shall be included as part of the Contract Documents. The responsibility and the necessity of providing materials and workmanship required by the Specifications and Drawings which may not be indicated on the shop drawings shall be included as part of the Contract Documents. The Contractor is responsible for any delays in job progress occurring directly or indirectly from late submissions or re-submissions of shop drawings, product data, or samples.

H. Ordering Equipment: No material shall be ordered or shop work started until the Engineer has officially received the shop drawings record submittal and has formally released the Contractor for submittal requirements.
I. Technical Data: Submit technical data verifying that the item submitted complies with the requirements of the specifications. Technical data shall include manufacturer's name and model number, dimensions, weights, electrical characteristics, and clearances required. Indicate optional equipment and changes from the standard item as called for in the specifications. Provide drawings, or diagrams, dimensioned and in correct scale, covering equipment, showing arrangement of components and overall coordination.

J. Same Manufacturer: In general, relays, contactors, starters, motor control centers, switchboards, panelboards, dry type transformers, disconnect switches, circuit breakers, manual motor starter switches, etc., shall be supplied and manufactured by the same manufacturer. This requirement shall apply to same type of electrical components specified in other Divisions.

2.03 EQUIPMENT, MATERIALS, AND SUPPORTS
A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacturer of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear the UL label.
B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer, however, the methods shall not be less stringent than specified herein.
C. Required Accessories: Provide all devices and materials, such as expansion bolts, foundation bolts, screws, channels, angles, and other attaching means, required to fasten enclosures, raceways, and other electrical equipment and materials to be mounted on structures which are existing or new.
D. Protection: Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by the elements. Equipment shall be stored in dry permanent shelters. If apparatus has been damaged, such damage shall be repaired at no additional cost or time extension to the Contract. If apparatus has been subject to possible injury, it shall be thoroughly cleaned, dried out and put through tests as directed by the Manufacturer and Engineer, or shall be replaced, if directed by the Engineer, at no additional cost to the Contract.

2.04 IDENTIFICATION OF EQUIPMENT
A. General: Electrical items shall be identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system, which it serves or controls. Refer to Identification Section of the specifications for additional information.

2.05 CONCRETE PADS
A. General: Provide reinforced concrete pads for floor mounted electrical equipment. Unless otherwise noted, pads shall be nominal four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by six (6) inches on all sides, except when equipment is flush against a wall, then the side or sides against the wall shall be flush with the equipment. Chamfer top edges 1/2". Trowel surfaces smooth. Reinforce pads with #5 reinforcing bars at 24" centers each way, unless specifically detailed on drawings.

2.06 SURFACE MOUNTED EQUIPMENT
A. General: Surface mounted fixtures, outlets, cabinets, panels, etc. shall have a factory-applied finish or shall be painted as accepted by Engineer. Raceways and fittings, where allowed to be installed surface mounted, shall be painted to match the finish on which it was installed. Paint shall be in accordance with other applicable sections of these specifications.

2.07 CUTTING AND PATCHING
A. Core Drilling: The Contractor shall be responsible for core drilling as required for work under this section, but in no case shall the Contractor cut into or weld onto any structural element of the project without the written approval of the Architect.
B. Cutting and Patching: Cutting, rough patching and finish patching shall be provided as specified in the contract documents. Cutting and patching shall be performed in a neat and workmanlike manner. Upon completion, the patched area shall match adjacent surfaces.
C. Openings and Sleeves: Locate openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.
D. Roof Penetration: Provide roofer with pitch pans, fittings, etc., required for electrical items which penetrate the roof. Roof penetrations are to be waterproofed in such a manner that roofing guarantees are fully in force. Roof penetrations shall be coordinated with other Trades to ensure that roof warranty is not invalidated.

BASIC ELECTRICAL REQUIREMENTS
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2.08 SLEEVES AND FORMS FOR OPENINGS

A. Sleeves: Provide sleeves for Raceways penetrating floors, walls, partitions, etc. Locate necessary slots for electrical work and form before concrete is poured. Watertight sleeves shall be line seal type WS. Fire rated partition sleeves shall be mild steel. Sleeves shall be Schedule 40 PVC or galvanized rigid steel unless specifically noted otherwise. Size shall be one standard diameter larger than pipe being installed or of a larger diameter to below 1/4" minimum clearance.

B. Forms: Provide boxed out forms for Raceway penetrations only where allowed by the Architect. Fill opening after Raceway installation, with equivalent material.

2.09 OPERATING AND MAINTENANCE INSTRUCTIONS

A. General: Thoroughly instruct the Owner’s Representative, to the complete satisfaction of the Architect and Engineer, in the proper operation of all systems and equipment provided. The Contractor shall make all arrangements, via the Architect, as to whom the instructions are to be given in the operation of the systems and the period of time in which they are to be given. The Architect shall be completely satisfied that the Owner’s Representative has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by the Contractor to the Owner's Representative, then the Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the Specification has been complied with.

B. Submittals: Submit to the Architect for approval five (5) typed sets, bound neatly in loose-leaf binders, of instructions for the installation, operation, care and maintenance of equipment and systems, including instructions for the ordering and stocking of spare parts for equipment installed under this contract. The lists shall include part number and suggested suppliers. Each set shall also include an itemized list of component parts that should be kept on hand and where such parts can be purchased.

C. Information Requirements: Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section shall be clearly divided from the other sections. A sub index for each section shall also be provided.

D. Instructions: The instructions shall contain information deemed necessary by the Architect and include but not limited to the following:

1. Introduction:
   c. Purpose of systems.

2. System:
   a. Detailed description of all systems.
   b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.

3. Operations:
   a. Complete detailed, step by step, sequential description of all phases of operation for all portions of the systems, including start up, shutdown and balancing. Include posted instruction charts.

4. Maintenance:
   a. Parts list and part numbers.
   b. Maintenance and replacement charts and the Manufacturer's recommendations for preventive maintenance.
   c. Trouble shooting charts for systems and components.
   d. Instructions for testing each type of part.
   e. Recommended list of on-hand spare parts.
   f. Complete calibration instructions for all parts and entire systems.
   g. General and miscellaneous maintenance notes.

5. Manufacturer's Literature:
   a. Complete listing for all parts.
   b. Names, addresses and telephone numbers.
   c. Care and operation.
   d. All pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
   e. Internal wiring diagrams and Engineering data sheets for all items and/or equipment furnished under each Contract.
   f. Guarantee and warranty data.
2.10 SERVICE AND METERING
   A. Company: The utility serving this project is Seguin Electrical Department which will be referred to as the Utility herein.
   B. Service: Make arrangements with the Utility for obtaining a complete service. Pay charges and provide labor and material for the service.
   C. Fees: Contact the Utility Company to determine if any fees, charges or costs will be due the Company, as required for temporary power, permanent power, installations, hook-ups, etc. This fee, charge or cost shall be included in the bid price.
   D. Payment: Pay for required licenses, fees and inspections. Include costs in the proposed construction cost submission. These costs shall include but not be limited to applicable taxes, permits, necessary notices, certificates and costs required to obtain same.
   E. Codes: Install a complete system in accordance with the 2011 edition of the National Electrical Code and the latest regulations of governing local, State, County and other applicable codes, including the Utility Company requirements.
   F. Provide transformer pad per Utility Company requirements.

2.11 TEMPORARY LIGHT AND POWER
   A. Capacity: Make arrangements with the Owner for existing temporary service and pay all related expenses. Temporary light and power shall be provided constantly during the project dependent upon Owner's safety requirements.
   B. Lighting: Temporary light shall be based on one 3910 Lumens lamp covering each 1,000 square foot of floor area in the building. Each room 100 square foot and over shall have a minimum of one 1710 Lumen lamp with guards. Provide power for motors up to 3/4 horsepower only. Provisions are to be made for electric welders, if required.
   C. Outlets: Provide outlets located at convenient points so that extension cords of not over fifty (50) feet will reach work requiring artificial light or power.
   D. Other Connections: Contractors of other trades shall furnish their own cords and sockets, as may be required for their work and shall also pay for cost of temporary wiring of construction offices and shanties used by them.
   E. New Fixtures: Permanently installed lighting fixtures may be used for temporary lighting at the Contractor's option with the provision that cool white lamps for fluorescent, clear lamps for incandescent and marked temporary for other types shall be installed. At job completion, lamps shall be replaced with permanent lamps specified.
   F. Wiring: Temporary electrical work shall be furnished and installed in conformity with the National Electrical Code and in accordance with the requirements of the local ordinances and shall be maintained in a workmanlike manner throughout their entire construction period and shall be removed after installation of the permanent electrical systems. Extension cords shall be GFCI protected or shall be fed from GFCI circuit breakers.
   G. Payment: The Owner will pay for the cost of energy consumed by all trades. Any temporary wiring of a special nature for light and power required other than mentioned above shall be paid for by the Contractor using same.

PART 3 - EXECUTION

3.01 WORKMANSHIP
   A. General: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.
   B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function, conforming to applicable standards of building system construction, and exhibiting a high degree of quality and proficiency which is judged by the Architect as equivalent or better than that ordinarily produced by qualified industry tradesmen.
   C. Performance: Personnel shall not be used in the performance of the installation of material and equipment who, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship and not acceptable to the Architect, shall be removed and reinstalled by qualified craftsmen, at no change in the contract price.
3.02  PROTECTION AND CLEAN UP
   A. Protection and Restoration: Suitably protect equipment provided under this Division during construction. Restore damaged surfaces and items to "like new" condition before a request for substantial completion inspection.
   B. Handling: Materials shall be properly protected and Raceway openings shall be temporarily closed by the Contractor to prevent obstruction and damage. Post notice prohibiting the use of systems provided under this Contract, prior to completion of work and acceptance of systems by the Owner's representative. The Contractor shall take precautions to protect his materials from damage and theft.
   C. Safeguards: The Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or systems provided under this contract.
   D. Cleanup: Keep the job site free from debris and rubbish. Remove debris and rubbish from the site and leave premises in clean condition on a daily basis.

3.03  SYSTEMS GUARANTEE
   A. General: Provide a one-year guarantee. This guarantee shall be by the Contractor to the Owner for any defective workmanship or material, which has been provided under this Contract at no cost to the Owner for a period of one year from the date of substantial completion of the System. The guarantee shall include lamps, for ninety days after date of Substantial Completion of the System. Explain the provisions of guarantee to the Owner at the "Demonstration of Completed System".

3.04  FINAL OBSERVATION
   A. General: Work shall be completed, and forms and other information shall be submitted for acceptance one week prior to the request for final observation of the installation.

3.05  SPECIAL CONSIDERATIONS
   A. Comply with special requirements imposed at site by Owner. This may include badging of employees, prohibition of smoking, special working hours, or special working conditions.

END OF SECTION
CERTIFICATE OF COMPLETED DEMONSTRATION MEMO

Note to Contractor: Do not submit this form at the time Technical Information Brochure is submitted. Submit five copies of information listed below for checking at least one week before scheduled completion of the building. After information has been accepted and inserted in each brochure, give the Owner a Demonstration of the Completed Electrical Systems and have the Owner sign five copies of this form. Provide one signed copy for each brochure. After this has been done, a written request for a final inspection of the System shall be made.

Re: __________________________________________________________
(Name of Project)

___________________________________________________________________________
(Division Number and Name)

This memo is for the information of all concerned that the Owner has been given a Demonstration of the Completed Electrical Systems on the work covered under this Division. This conference consisted of the system operation, a tour on which all major items of equipment were pointed out, and the following items were given to the Owner;

(a) Owner’s copy of Technical Information Brochure containing approved submittal sheets on all items, including the following; (To be inserted in the Technical Information Brochure after the correct tab).
   (1) Maintenance Information published by manufacturer on equipment items.
   (2) Printed Warranties by manufacturers on equipment items.
   (3) Performance verification information as recorded by the Contractor.
   (4) Check-out Memo on equipment by manufacturer’s representative.
   (5) Written operating instructions on any specialized items.
   (6) Explanation of the one-year guarantee on the system.

(b) "As-Built" conditions as described in the record drawing specifications.
(c) A demonstration of the System in Operation and of the maintenance procedures which shall be required.

__________________________________________________________________________
(Name of General Contractor)

By: __________________________________________________________________________
(Authorized Signature, Title & Date)

__________________________________________________________________________
(Name of SubContractor)

By: __________________________________________________________________________
(Authorized Signature, Title & Date)

Brochure, Instruction, Prints, Demonstration & Instruction in Operation Received:

__________________________________________________________________________
(Name of Owner)

By: __________________________________________________________________________
(Authorized Signature, Title, Date)

cc: Owner, Architect, Engineer, Contractor, Sub Contractor and General Contractor
(List names as stated in cc: above)
SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing agency.
   B. Field quality-control reports.

1.5 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.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES
A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. Alcan Products Corporation; Alcan Cable Division.
   2. Alpha Wire.
   3. Belden Inc.
   5. General Cable Technologies Corporation.
   B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
   C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.
   D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES
A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. AFC Cable Systems, Inc.
   2. Gardner Bender.
   4. Ideal Industries, Inc.
   5. Ilsco; a branch of Bardes Corporation.
   6. NSI Industries LLC.
   7. O-Z/Gedney; a brand of the EGS Electrical Group.
   8. 3M; Electrical Markets Division.
   B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.

**PART 3 - EXECUTION**

3.1 **CONDUCTOR MATERIAL APPLICATIONS**
   A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
   B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 **CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS**
   A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.
   B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.
   C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
   D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
   E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
   F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.
   G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
   H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 **INSTALLATION OF CONDUCTORS AND CABLES**
   A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
   B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
   C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
   D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceways.
   E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
   F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 **CONNECTIONS**
   A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
   B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
      1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
   C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 **IDENTIFICATION**
   A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
   B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 **SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**
   A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 **FIRESTOPPING**
   A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."
3.8 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform the following tests and inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
      a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
      b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
C. Test and Inspection Reports: Prepare a written report to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
D. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION
SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes methods and materials for grounding systems and equipment.

1.3 GROUNDING ELECTRODES
   A. General: Provide a grounding electrode system, as described in NEC 250, as specified herein and as
      indicated on plans.
   B. Ground Field / Ground Rods: The ground field shall consist of three 10 ft long vertically driven ground rods
      arranged in a triangular pattern spaced 20 feet apart. Additional ground rods shall be added as necessary
      to achieve the desired resistance.
   C. Main Metallic Water Pipe: The building’s main metallic underground water piping shall be utilized as a
      grounding electrode, provided the metal pipe is installed in direct contact with the earth for a minimum of
      10 feet. Bond the main metallic water service within 5 ft. of the entrance of the water pipe into the building.
   D. Building Steel: The building steel shall be utilized as a grounding electrode, provided the steel is in direct
      contact with the earth or is otherwise effectively grounded.
   E. Rebar: In concrete buildings, provide bond to rebar in concrete.
   F. Resistance: Grounding electrode resistance shall not exceed 10 ohms. Overall resistance of the entire
      grounding electrode system shall not exceed 5 ohms. Provide additional grounding electrodes as required
      to meet this value.

1.4 GROUNDING ELECTRODE CONDUCTOR
   A. Grounding Electrode Conductor: A main grounding electrode conductor, bare copper, sized per NEC,
      shall be run in PVC conduit from main service equipment to the grounding electrodes. This conductor shall
      also be bonded to the following:
      1. Telecommunications service ground within 20’ of the electrical service
      2. Gas and other interior metal piping – refer to NEC.

1.5 SEPARATELY DERIVED GROUNDING SYSTEMS
   A. Description: Provide a separately derived grounding system where indicated herein and as required by
      the National Electrical Code. Bond neutral and ground busses together.
   B. Services: Provide a separately derived grounding system for all building electrical services and step-down
      transformers.

1.6 BONDING AND EQUIPMENT GROUNDING
   A. Description of System: In general, all electrical equipment (metallic conduit, motor frames, panelboards,
      etc.) shall be bonded together with a green insulated copper system grounding conductor in accordance
      with specific rules of Article 250 of the NEC Equipment grounding conductors through the raceway system
      shall be continuous from main switch ground bus to panel ground bar of each panelboard, and from panel
      grounding bar of each panelboard to branch circuit equipment and devices.
   B. Equipment Grounding Conductors: All raceways shall have an insulated copper system ground conductor
      run throughout the entire length of circuit installed within conduit in strict accordance with NEC. Grounding
      conductor shall be included in total conduit fill when determining conduit sizes, even though not included or
      shown on drawings.
   C. Redundant Grounding: In general all branch circuits shall be provided with a redundant grounding system
      through the use of grounding conductors and metallic conduit.
   D. Bonding: Provide bonding of the equipment grounding terminal busses of normal and essential branch
      circuit panelboards serving the same patient area with a continuous #10 AWG copper green insulated
      conductor, in compliance with NEC 517-14.
   E. Bonding: In addition to connections to grounding electrodes, the main service ground shall be bonded to
      the lightning protection system and other underground metal piping.
F. Light Poles: All exterior light poles shall have their enclosures grounded directly to a separate driven ground at the light pole in addition to the building ground connection, via the circuit equipment ground conductor.

G. Bushings: Provide insulated grounding bushings on all metallic feeder conduits terminated within panelboards, switchboards or enclosed overcurrent devices. Provide insulated grounding bushings on all branch circuit conduits where concentric knockouts are used.

H. Connection to Other Systems: Provide all required grounding and bonding connections as specified herein and as required by the National Electrical Code.

1.7 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Grounding arrangements and connections for separately derived systems.
C. Qualification Data: For testing agency and testing agency’s field supervisor.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
   1. Instructions for periodic testing and inspection of grounding features at test wells based on NETA MTS.
      a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
      b. Include recommended testing intervals.

1.8 QUALITY ASSURANCE
A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS
A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
B. Bare Copper Conductors:
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
   1. No. 4 AWG minimum, soft-drawn copper.
   2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch (7.14-mm) holes space 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600V. Lexan or PVC, impulse tested at 5000V.
2.2 CONNECTORS
   A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
   B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
      1. Pipe Connectors: Clamp type, sized for pipe.
   C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES
   A. Ground Rods: Copper-clad; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS
   A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
   B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
      1. Bury at least 24 inches (600 mm) below grade.
      2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
   C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
   D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
      1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
      2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
   E. Conductor Terminations and Connections:
      1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
      2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
      3. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS
   A. Comply with IEEE C2 grounding requirements.
   B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

3.3 EQUIPMENT GROUNDING
   A. Install insulated equipment grounding conductors with all feeders and branch circuits.
   B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
      1. Feeders and branch circuits.
      2. Lighting circuits.
      3. Receptacle circuits.
      5. Three-phase motor and appliance branch circuits.
      6. Flexible raceway runs.
      7. Armored and metal-clad cable runs.

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260526 - 3
C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3 by-100-by-300-mm) grounding bus.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

F. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
   2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole.
   1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 LABELING

A. Comply with requirements in Division 26 Section “Identification for Electrical Systems” Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: “If this connector or cable is loose or if it must be removed for any reason, notify the facility manager.”

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer’s written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.

3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.


F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION
EQUIPOTENTIAL GROUND TEST REPORT

FACILITY NAME: _______ PROJECT NAME: ________________________________

DATE: _______ TESTED BY: __________________

MAXIMUM TEST INTERVALS: ______________________________________

GENERAL CARE - 12 MOS.
CRITICAL CARE - 6 MOS.
WET LOCATIONS - 12 MOS.

NAME: ________________ COMPANY: ________________

TYPE METER USED AND EXTERNAL NETWORK IF USED:

NOTE: MAXIMUM READINGS PERMITTED - 20 MV NEW - CONSTRUCTION / RENOVATION
0.1 OHM NEW - CONSTRUCTION / RENOVATION

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SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following:
1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS
A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

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 installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesancco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.
B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: All-steel springhead type.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES
   A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
   B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION
   A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
   B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
   C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
      1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.
   D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION
   A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
   B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
   C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 and Spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03.
C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Metal conduits, tubing, and fittings.
      2. Nonmetal conduits, tubing, and fittings.
      3. Metal wireways and auxiliary gutters.
      4. Nonmetal wireways and auxiliary gutters.
      5. Surface raceways.
      7. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS
   A. EMT: Electrical metallic tubing.
   B. ENT: Electrical nonmetallic tubing.
   C. EPDM: Ethylene-propylene-diene terpolymer rubber.
   D. FMC: Flexible metal conduit.
   E. GRC: Galvanized rigid steel conduit.
   F. IMC: Intermediate metal conduit.
   G. LFMC: Liquidtight flexible metal conduit.
   H. LFNC: Liquidtight flexible nonmetallic conduit.
   I. RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS
   A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and
      cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. AFC Cable Systems, Inc.
      2. Allied Tube & Conduit
      3. Anamet Electrical, Inc.
      4. Electri-Flex Company.
      5. O-Z/Gedney
      6. Picoma Industries
      7. Republic Conduit.
      8. Robroy Industries.
      10. Thomas & Betts Corporation.
      11. Western Tube and Conduit Corporation.
      12. Wheatland Tube Company
   B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70,
      by a qualified testing agency, and marked for intended location and application.
   C. GRC: Comply with ANSI C80.1 and UL 6.
   D. IMC: Comply with ANSI C80.6 and UL 1242.
   E. PVC Coated Steel Conduit: PVC coated [rigid steel conduit] [IMC]
      1. Comply with NEMA RN 1.
      2. Coating Thickness: 0.040 inch (1 mm), minimum
      3. Comply with ETL Verified PVC-001.
F. EMT: Comply with ANSI C80.3 and UL 797.
G. FMC: Comply with UL 1; zinc-coated steel or aluminum.
H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel.
      b. Type: Setscrew or compression indoors; compression for outdoors.
   3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
J. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Amico Corporation.
   3. CANTEX Inc.
   4. CertainTeed Corp.
   7. Lamson & Sessions; Carlon Electrical Products.
   8. Kraloy.
   9. Niedax-Kleinhuis USA, Inc.
   10. RACO; a Hubbell company.
B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. ENT: Comply with NEMA TC 13 and UL 1653.
D. RNC: Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.
E. LFNC: Comply with UL 1660.
F. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
G. Fittings for LFNC: Comply with UL 514B.
H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Hoffman
   4. Square D; a brand of Schneider Electric.
B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R (as required) unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
D. Wireway Covers: Screw-cover type unless otherwise indicated.
E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS
A. Refer to drawings.
B. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

c. Surface Metal Raceways and Tele-pole poles: Manufacturer's standard enamel finish in color selected by Architect.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Mono-Systems, Inc.
      b. Panduit Corp.
      c. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Adalet.
   2. Cooper Technologies Company; Cooper Crouse-Hinds.
   3. EGS/Appleton Electric.
   5. FSR Inc.
   6. Hoffman
   7. Hubbell Incorporated
   8. Kraloy.
   10. Mono-Systems, Inc.
   11. O-Z/Gedney
   12. RACO; Hubbell.
   13. Robroy Industries.
   14. Spring City Electrical Manufacturing Company.
   15. Stahlin Non-Metallic Enclosures
   17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:
   1. Refer to drawings.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
   1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

L. Gangable boxes are prohibited.

M. Cabinets:
   1. NEMA 250, Type 1 or Type 3R (as requested) galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. NewBasis.
   d. Oldcastle Precast, Inc.
   e. Quazite: Hubbell Power Systems, Inc
   f. Synertech Moulded Products

2. Standard: Comply with SCTE 77.

3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.

4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

6. Cover Legend: Molded lettering, “ELECTRIC.”

7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.


2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.

2. Concealed Conduit, Aboveground: IMC.


4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed: EMT.

2. Concealed in Ceilings and Interior Walls and Partitions: EMT.

3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

4. Damp or Wet Locations: IMC.

5. Boxes and Enclosures: NEMA 250, Type 1.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with NEC 1 and NEC 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes.

C. Install horizontal raceway runs above water and steam piping.

D. Complete raceway installation before starting conductor installation.

E. Comply with requirements in Division 26 Section “Hangers and Supports for Electrical Systems” for hangers and supports.
E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.
G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
H. A. Support conduit within 12 inches (300 mm) of enclosures to which attached.
I. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. Change from RNC to IMC before rising above floor.
J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35 mm) trade size and insulated throat metal bushings on 1-1/2-inch (41 mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
P. Cut conduit perpendicular to the length. For conduits 2-inch (53 mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
R. Surface Raceways:
   1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Where otherwise required by NFPA 70.
U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) (minimum of 36 inches) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC in damp or wet locations not subject to severe physical damage.
W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Y. Locate boxes so that cover or plate will not span different building finishes.

Z. Support boxes of three gangs or more from one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

CC. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
   5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
      b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
   6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
   7. Underground Warning Tape: Comply with requirements in Division 26 Section "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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3.7 PROTECTION
   A. Protect coatings, finishes, and cabinets from damage and deterioration.
      1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
      2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION
SECTION 260544
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
5. Silicone sealants.
B. Related Requirements:
1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES
A. Wall Sleeves:
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
F. Sleeves for Rectangular Openings:
2. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS
A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS
A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
      a. Presealed Systems.

2.4 GROUT
A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS
A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
   2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS
A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Debur after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION
SECTION 260553

ELECTRICAL IDENTIFICATION

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. Identification for raceways.
      2. Identification of power and control cables.
      3. Identification for conductors.
      5. Warning labels and signs.
      6. Instruction signs.
      7. Equipment identification labels.
      8. Miscellaneous identification products.

1.3 QUALITY ASSURANCE
   A. Comply with ANSI A13.1.
   B. Comply with NFPA 70.
   D. Comply with ANSI Z535.4 for safety signs and labels.
   E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION
   A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
   B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
   C. Coordinate installation of identifying devices with location of access panels and doors.
   D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS
   A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
   B. Colors for Raceways Carrying Circuits at 600 V or Less:
      1. Black letters on an orange field.
      2. Legend: Indicate voltage and system or service type.
   C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS
   A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
   B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 CONDUCTOR IDENTIFICATION MATERIALS
   A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
2.4 FLOOR MARKING TAPE
   A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 UNDERGROUND-LINE WARNING TAPE
   A. Tape:
      1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
      2. Printing on tape shall be permanent and shall not be damaged by burial operations.
      3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
   B. Color and Printing:
      1. Comply with ANSI Z535.1 through ANSI Z535.5.
      2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
      3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
   C. Tag: Type I:
      1. Pigmented polyolefin, bright-colored, compounded for direct-burial service.
      2. Thickness: 4 mils (0.1 mm).
      3. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
      4. 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf (133.4 N), and 2500 psi (17.2 MPa).

2.6 WARNING LABELS AND SIGNS
   B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
   C. Warning label and sign shall include, but are not limited to, the following legends:
      1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
      2. Arc Flash: Provide permanent warning labels on all electrical switchboards, switchgear, electrical panels, meter socket enclosures, and motor control centers, to warn personnel of potential electric arc flash hazards per NEC 110.16. The Owner shall determine the potential for arc flash hazard level in accordance with NFPA 70E and OSHA.

2.7 INSTRUCTION SIGNS
   A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
      1. Engraved legend with black letters on white face.
      2. Punch or drilled for mechanical fasteners.
      3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
   B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
   C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.8 EQUIPMENT IDENTIFICATION LABELS
   A. Engraved Plastic Laminate Nameplates:
      1. Provide engraving phenolic plastic laminate, in sizes and thicknesses indicated, engraved with 1/16 inch thick lines with square standard pica lettering and wording as specified herein.
         a. black face with white core plies (letter color) for normal systems
      2. Punch for mechanical fastening, except where adhesive mounting is necessary because of substrate.
      3. Material thickness shall be 1/16 inch. Titles shall be 1/2 inch high and all other lettering shall be 1/4 inch high.
      4. Provide beveled edge in order to eliminate sharp corners.
      5. Provide self-tapping stainless steel round head screws. Provide contact type permanent adhesive where screws cannot or shall not penetrate the substrate. Adhesive nameplate shall be permanently installed.
2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
   1. Minimum Width: 3/16 inch (5 mm).
   2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
   1. Minimum Width: 3/16 inch (5 mm).
   2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
   3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
   1. Minimum Width: 3/16 inch (5 mm).
   2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
   5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

I. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
   1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to raceways concealed within wall.
   3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.

C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of all systems with with colors indicated in the wiring system legend. For all power circuits, indicate the panel & circuit number and system voltage on the box cover.

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
      b. Colors for 208/120-V Circuits (verify with Town):
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
      c. Colors for 480/277-V Circuits (verify with "Town):
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
      d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

E. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Controls with external control power connections.

J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:
   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
   b. Enclosures and electrical cabinets.
   c. Access doors and panels for concealed electrical items.
   d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
   e. Emergency system boxes and enclosures.
   f. Enclosed switches.
   g. Enclosed circuit breakers.
   h. Enclosed controllers.
   i. Variable-speed controllers.
   j. Push-button stations.
   k. Contactors.
   l. Remote-controlled switches, dimmer modules, and control devices.
   m. Battery-inverter units.
   n. Battery racks.
   o. Monitoring and control equipment.
   p. Light switch cover plate. Provide 3/16 inch engraved and "filled in" lettering indicating panelboard and circuit number "where fed from" for all switches. Fill white coverplates with black filler.
   q. Receptacle coverplate: Provide 3/16 inch engraved and "filled in" lettering indicating panelboard and circuit number "where fed from" for all receptacles. Fill white coverplates with black filler.

        END OF SECTION
SECTION 260573
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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 computer-based, fault-current, overcurrent protective device coordination study and arc flash study. Protective devices shall be set based on results of the protective device coordination study.

1.3 ACTION SUBMITTALS
   A. Product Data: For computer software program to be used for studies.
   B. Action Submittal: A preliminary fault-current study shall be submitted with the electrical equipment submittal validating the proposed equipment fault interrupting ratings.
   C. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
      1. Coordination-study input data, including completed computer program input data sheets.
      2. Study and Equipment Evaluation Reports.
      4. Arc flash study report.

1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For coordination-study specialist.
   B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE
   A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
   B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
      1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
   C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
   D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS
   A. Basis-of-Design Product: Subject to compliance with requirements, provide product by the following:
      1. SKM Systems Analysis, Inc.
      2. Or equivalent.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS
   A. Comply with IEEE 242 and IEEE 399.
   B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
   C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
      1. Optional Features:
         a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA
A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.
   4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
      c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
      d. Generator thermal-damage curve.
      e. Ratings, types, and settings of utility company’s overcurrent protective devices.
      f. Special overcurrent protective device settings or types stipulated by utility company.
      g. Time-current-characteristic curves of devices indicated to be coordinated.
      h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
      i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
      j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY
A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
   1. Distribution panelboard.
   2. Branch circuit panelboard.
B. Study electrical distribution system from normal throughout electrical distribution system for Project.
C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE and IEEE 242.

E. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:
   1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
   3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

   1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
   2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
   3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
   1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      a. Device tag.
      b. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
      c. Fuse-current rating and type.
      d. Ground-fault relay-pickup and time-delay settings.
   2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company’s upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
      a. Device tag.
      b. Voltage and current ratio for curves.
      c. Three-phase and single-phase damage points for each transformer.
      d. No damage, melting, and clearing curves for fuses.
      e. Cable damage curves.
      f. Transformer inrush points.
      g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.
SECTION 260800

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
B. Related Sections: Refer to Division 01 Section 019114 “General Commissioning Requirements for additional commissioning scope and requirements. All testing and commissioning requirements of that section shall be met.
C. The Commissioning Team will include representatives of the Owner, Design A/E, General Contractor and Installing Subcontractors, Test and Balance Subcontractor, BAS Subcontractor and Commissioning Authority (CxA).
   1. Lighting and daylighting controls List any additional systems.
   2. Receptacles.

1.2 CONTRACTOR'S RESPONSIBILITIES
A. Attend the Commissioning Kick-off meeting and other Commissioning meetings as required.
B. Attend construction phase coordination meetings.
C. Attend testing, adjusting, and balancing review and coordination meetings.
D. Complete Pre-Functional Checklists (PFCs) for all systems and equipment to be commissioned. Sign and submit the PFC's using the submittal process for tracking. The checklists should be completed and signed by the technician performing the work. Sampling is not permitted; 100% of all equipment shall be tested.
E. Submit completed manufacturer’s start-up checklists for the equipment being commissioned. Manufacturer’s start-up documents shall be provided in addition to the completed and signed Pre-Functional Checklists.
F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period. Provide meters, gauges and instruments for Functional Performance Testing.
G. Perform all commissioning tests at the direction of the CxA.
H. Complete tasks required to correct items noted by the CxA in the Deficiency Log.
I. Participate in systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
J. Provide O&M data including wiring diagrams, sequences of operation, single line drawings, warranties, tables, recommended maintenance schedules, checklists, spare parts lists, wiring and parts diagrams, points of contact for service, for all equipment, systems and controls being commissioned.
K. Provide training of the Owner's operations and maintenance personnel in accordance with the project's construction documents and commissioning plan.
L. Provide information requested by the CxA for final commissioning documentation.

1.3 CxA's RESPONSIBILITIES
A. Provide Project-specific construction checklists and commissioning process test procedures for actual Electrical systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
B. Provide a Commissioning Plan.
C. Provide Pre-Functional Checklists.
D. Provide Functional Performance Checklists.
E. Direct commissioning testing.
F. Maintain and distribute the deficiency logs.
G. Provide a Preliminary Commissioning Report to the Owner a minimum of 10 days prior to Final Inspection. The General Contractor will ensure that a copy of the draft report is available on site for review by the building official. The preliminary report shall include the following as a minimum:
   • Results of the Lighting and daylighting controls and equipment testing in separate sections for independent review.
   • Itemized deficiencies found during testing that have not yet been corrected at the time the report is issued.
   • Tests that cannot be completed at the time of report preparation, and reasons that the testing could not be completed.
H. Review the O&M documents for clarity and completeness.
I. Review an O&M Manual that is prepared by the General Contractor and provided to the Owner and includes the following:
   • Submittal data stating selected size and options for each piece of equipment.
   • Name and address of at least one qualified service agency.
   • Lighting and daylighting controls system maintenance and calibration information. Include wiring diagrams, schematics, and control sequences descriptions.
   • Desired or field determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in the programming instructions.

J. Provide a Final Commissioning Report. The final report shall include the following as a minimum:
   • Results of the Functional Performance Tests.
   • Disposition of deficiencies found during testing, including the details of corrective measures used or proposed.
   • Functional performance tests procedures during the commissioning process, including measurable criteria for test acceptance, provided for repeatability.

1.4 PROCESS
A. Functional Performance Testing will commence after preliminary punch list items are completed by the Contractor. Functional Performance Testing will not be scheduled until the completed Pre-Functional Checklists are received by the Commissioning Authority.

1.5 SUBMITTALS
A. Certificate of Readiness indicating the Electrical systems are ready for Commissioning.
B. Completed Pre-Functional Checklists shall be provided as a submittal for tracking purposes. Pre-Functional Checklists shall be completed and signed by the technician performing the work. Sampling is not permitted for the completion of the Pre-Functional Checklists.
C. Manufacturer’s start-up checklists.
D. Lighting and Daylighting Control System point to point checklists.
E. Sixty (60) days before any electrical testing is conducted, provide an overall testing plan and schedule for electrical, lighting control and daylighting control systems that lists the equipment, modes to be tested, dates of testing and parties required to conduct the test. Put this information in to the master construction schedule. Keep the plan and schedule updated.

1.6 COMMISSIONING DOCUMENTATION
A. Provide the following information to the CxA for inclusion in the commissioning documentation (commissioning plan or Systems Manual):
   1. Approved submittals with designer review comments of submittals resolved, operation and maintenance manuals, and assistance in drafting the systems manuals, and other documents and reports requested by the Commissioning Authority in searchable pdf format.
   2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase on as built markup of the design documents (plans and specifications).
   3. Process and schedule for completing construction checklists and manufacturer’s prestart and startup checklists for Electrical systems, assemblies, equipment, and components to be verified and tested.
   4. Completed PFCs certifying that installation, prestart checks, and startup procedures have been completed.
   5. Schedule indicating when Electrical systems, subsystems, equipment, and associated controls will be ready for functional testing. The date for permanent connection of power is required.
   6. Corrective action documents.
   7. The Contractor shall provide updated “As-Built” single line drawings for Power, Lighting, Lighting Control and Daylighting Control systems. The drawings are to be provided in the electronic format requested by the CxA. The drawings are required for inclusion in the Systems Manual that will be prepared by the CxA.
   8. The Contractor shall provide updated “As-Built” Lighting Control and Daylighting Control sequences of operation for inclusion in the Systems Manual.
   9. Any additional information requested by the CxA.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL
A. The Contractor shall be responsible for performing procedures presented in specification and contract drawings as detailed in the Functional Performance Tests (FPT). Members of the designated Commissioning Team shall witness various portions of the commissioning process. Commissioning Team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the Owner and CxA.
B. Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by the Contractor.
C. Contractor shall provide to the Commissioning 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 TESTING PREPARATION
A. Certify in writing the Electrical systems, subsystems, and equipment and controls have been installed, calibrated, started and are operating per the Contract Documents. Ensure the PFCs are completed and submitted by factory authorized start up tech and submitted to the Contractor.
B. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
C. Inspect and verify the position of each device and interlock identified in the sequences, control schematics and or on checklists.
D. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
E. Testing Instrumentation: Install measuring instruments and logging devices to record test data if directed by the CxA in the Commissioning Plan.

3.3 GENERAL TESTING REQUIREMENTS
A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.
B. Refer to Section 019114 General Commissioning Requirements and the commissioning plan for the scope of Lighting and Daylighting controls testing.
C. Testing strategies and sampling: Refer to the Commissioning Plan for sampling strategies and functional performance test requirements.
D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of lighting and daylighting system controllers and sensors.
E. The CxA shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.
F. The Contractor shall execute the detailed testing plans, procedures, and checklists (PFCs and FPTs) prepared by the CxA for systems, subsystems, and equipment being commissioned.
G. Tests will be performed using design conditions whenever possible.
H. Simulated conditions may need to be imposed when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
I. The CxA may direct that set points be altered to achieve simulated conditions.
J. If tests cannot be completed because of a deficiency outside the scope of the system, the CxA will document the deficiency and report it to the Owner. After deficiencies are resolved, the Contractor will reschedule the tests.
K. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 INSTRUMENTATION
A. Instrumentation for Functional Performance Testing and data recording will be provided by the individual trade Subcontractors. 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 IEEE Standards.
B. Application of instruments and accuracy of measurements shall be in accordance with IEEE Standards.
3.5 INSTALLATION VERIFICATION
A. Before system start-up begins, the Contractor shall conduct a final installation verification audit. The Contractor shall be responsible for completion of work including change orders and punch list items to the Owner’s satisfaction.
B. If work is found to be incomplete, incorrect, or non-functional, the Contractor shall correct the deficiency before system start-up work proceeds.

3.6 SYSTEM START-UP & PRE-FUNCTIONAL CHECKLIST
A. System start-up shall be performed by the Contractor in accordance with the manufacturer’s written startup instructions and documented with the Pre-Functional Checklist (PFCs)
   1. Designated members of the Commissioning Team may witness system start-up and list system and equipment deficiencies noted during start-up, however that is not required for system start-up and PFC documentation to be performed.
   2. The Contractor shall take corrective action on system deficiencies found or noted and demonstrate and document proper 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.
B. Completed, signed-off PFCs shall be submitted once the system start up is complete for each system.

3.7 FUNCTIONAL PERFORMANCE TESTING
A. The objective of the Functional 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, design intent, and Owner requirements.
B. Functional Performance Testing begins after all PFCs have been completed, submitted, and reviewed by the CxA, and after Test and Balance has been completed.
C. Functional Performance tests for the systems to be commissioned are defined in the Commissioning Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.
   1. Draft Functional Performance Test procedures will be provided by the CxA to the Owner, Designers and Contractors for review and comments. Comments will be reviewed and incorporated into the final Functional Performance documents.
   2. Final Functional Performance Test documents will be provided for testing.
   3. Functional Performance Testing will be executed by the Contractors and witnessed by the CxA.
   4. Lighting and Daylighting Controls: Provide technicians, instrumentation, tools, and equipment to test performance of lighting control systems and daylighting control devices/systems.
   5. The Commissioning Authority develops specific written equipment, system and assembly Functional Performance Test (FPT’s) procedures for all commissioned Lighting and Daylighting controls and equipment. The following functions as a minimum will be tested:
      • Sampling of the occupancy sensors is permitted as follows (refer to the Commissioning Plan for additional information):
        ▪ If there are (7) occupancy sensors or less, all sensors shall be functionally tested.
        ▪ For systems with more than (7) sensors testing shall be done for each unique combination of sensor type and space geometry.
        ▪ Where multiples of each unique combination of sensor type and space geometry are provided, not less than 10% but in no case less than (1), of each combination, shall be tested unless the code official or design professional requires a higher percentage to be tested.
        ▪ Where 30% or more of the tested controls fail, all remaining identical combinations shall be tested.
        ▪ Refer to the Commissioning Plan for additional information. Where there is a difference between the Commissioning Plan and this specification, the Commissioning Plan shall be followed.
      • Occupancy Controls shall be tested as follows as follows:
        ▪ Verify status indicators are correct.
        ▪ The controlled lights turn off or down to the permitted level in the required time.
        ▪ For auto-on occupant sensor controls, the lights turn on to the permitted level when an occupant enters the space.
        ▪ For manual-on occupant sensor controls, the lights turn on only when manually activated.
        ▪ The lights are not incorrectly turned on by movement in adjacent areas of HVAC operation.
• **Time-Switch Controls shall be tested as follows:**
  - Confirm the time switch control is programmed with accurate weekday, weekend and holiday schedules.
  - Verify the correct time and date in the time switch.
  - Verify that any battery back-up is installed and energized.
  - Verify that the override time limit is set for no more than 2 hours.
  - Simulate an occupied condition and verify and document the following:
    - All lights can be turned on and off by their respective area control switch.
    - The switch only operates lighting in the enclosed space in which the switch is located.
  - Simulate an un-occupied condition and verify and document the following:
    - Nonexempt lighting turns off.
    - Manual override switch only allows the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.
    - Additional testing as specified by the registered design professional.
    - For manual-on occupant sensor controls, the lights turn on only when manually activated.
    - The lights are not incorrectly turned on by movement in adjacent areas.

• **Daylight Responsive Controls shall be tested as follows:**
  - Control devices have been properly located, field calibrated and set for accurate setpoints and threshold light levels.
  - Daylight controlled lighting loads adjust to light level setpoints in response to available daylight.
  - The locations of calibration equipment are readily accessible only to authorized personnel.

6. The test procedures are executed by the Contractor, under the direction of, and documented by the Commissioning Authority for most equipment.

3.8 NON-CONFORMANCE
A. The CxA will record the results of the Functional Performance Tests. All deficiencies, non-conformance issues, or test failures will be noted and reported to the Contractor in a deficiency list or in a punch-list format.
B. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
C. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owners Representative.
D. Re-testing.
  1. If a Functional Performance Test fails, corrections shall be made to the deficient equipment or systems by the Contractor. The systems will be re-tested until they pass the Tests.
  2. The time/cost for the CxA to perform any re-testing required because of improper set up of the systems by the Contractor or failed functional or performance tests will be back-charged to the Contractor (who may choose to recover costs from the party responsible for executing faulty equipment start-up/checkout and associated checklists). This includes instances where a specific item was overlooked in the equipment start-up and checkout procedures, reported to have been successfully completed, but determined during Functional Performance testing to be faulty.
  3. Any required re-testing by any Contractor or vendor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

END OF SECTION
SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Time switches.
   2. Photoelectric switches.
   4. Indoor occupancy sensors.
   5. Outdoor motion sensors.
   7. Emergency shunt relays.
B. Related Requirements:
   1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring.
   2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 TIME SWITCHES
A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   1. Cooper Industries, Inc.
   2. Intermatic, Inc.
   3. Invensys Controls.
   5. NSi Industries LLC; TORK Products.
   6. Tyco Electronics; ALR Brand.
   7. Lutron Electronics, Inc.
B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Contact Configuration: DPDT.
   3. Contact Rating: 30-A inductive or resistive, 240-V ac.
   4. Digital Program:
      a. Each relay is individually programmable via digital 24-hour and astronomic timeclock. 7 daily schedules, up to 500 events total for system and holiday schedules that override the weekly operation on selected dates.
      b. Contact input for signal from BMS or photocell programmable to any function
      c. After-hours mode of operation set to Flash-warn select relays at a programmable time, followed by shutting off all interior lighting at that select time unless a button press is made on the local controls overriding the after-hours mode. After a programmable time delay (up
to 3 hours per IECC), system will flash-warn lights left on again until end of after-hours mode
5. Circuity: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
6. Astronomic Time: All channels.
7. Automatic daylight savings time changeover with administrator-level programmable adjustment as to the beginning and end of daylight savings time without need for firmware upgrades or new parts.
8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.
9. Integration: Provide integration as required:
   a. BMS System via RS232
   b. BMS System via Contact Closure Input
   c. BMS System via BACnet IP
   d. AV System via RS232
   e. Theatrical dimming system via contact closure
   f. Theatrical dimming system via USITT DMX-512 input digitally controlling each relay

2.2 OUTDOOR PHOTOELECTRIC SWITCHES
A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   1. Cooper Industries, Inc.
   2. Intermatic, Inc.
   3. NSI Industries LLC; TORK Products.
   4. Tyco Electronics; ALR Brand.
   5. Lutron Electronics, Inc.
   6. PLC Multipoint
B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Light-Level Monitoring Range: 50fc to 500fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
   3. Time Delay: Fifteen second minimum, to prevent false operation.
   5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
C. Description: Solid state, with DPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Light-Level Monitoring Range: 50fc to 500fc, with an adjustment for turn-on and turn-off levels within that range.
   3. Time Delay: Thirty-second minimum, to prevent false operation.
   5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS
A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   1. Cooper Industries, Inc.
   2. Eaton Corporation.
   3. Hubbell Building Automation, Inc.
   5. Lithonia Lighting; Acuity Lighting Group, Inc.
   6. NSI Industries LLC; TORK Products.
   7. Sensor Switch, Inc.
   8. Tyco Electronics; ALR Brand.
   10. Lutron Electronics, Inc.
B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack if required or Wireless battery operated unit with minimum 10 year battery life, to detect changes in indoor lighting levels that are perceived by the eye.
C. Electrical Components, Devices, and Accessories:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   3. Sensor Output: Contacts rated to operate load directly, through the associated power pack, complying with UL 773A, or through lighting contactor. Sensor is powered by the power pack. For wireless types, RF signal transmitted to wall switches, relays, or lighting control system operating the connected load.
   4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 15-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 46100-mA, Class 2 power source, as defined by NFPA 70.
   5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
   6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
   7. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
   8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
   9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
   10. Test Mode: User selectable, overriding programmed time delay to allow settings check.
   11. Control Load Status: User selectable to confirm that load wiring is correct.
   12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS
A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   1. Cooper Industries, Inc.
   2. Hubbell Building Automation, Inc.
   4. Lithonia Lighting; Acuity Lighting Group, Inc.
   5. Watt Stopper.
   6. Lutron Electronics, Inc.
B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools or integral controls onboard the sensor.
      a. Initial setup tool.
      b. Tool for occupants to the electric lighting level via manual dimming.
C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Sensor Output: 0- to 10-V dc, RF wireless, or digital electronic signal to operate electronic dimming ballasts. Sensor is powered by controller unit for 0-10V and digital sensors. 10-year minimum battery life for wireless sensors.
   3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
   4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).
   5. User controls: output of dimmers cannot override photocell setting. Target light level should never be exceeded.

2.5 INDOOR OCCUPANCY SENSORS
A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   1. Bryant Electric; a Hubbell company.
   2. Cooper Industries, Inc.
   3. Hubbell Building Automation, Inc.
   5. Lightolier Controls.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric.
12. Watt Stopper.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack. Wireless sensors with minimum 10-year battery life.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack. For wireless type sensors, RF signal transmitted to wall switches, dimmers, or relays operating the connected load.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-100-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box. Wireless sensors to be mounted directly to hard ceilings via drywall screws or metal tie for acoustic ceilings.
   b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door or on rear of sensor.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
9. Relay output: provide where required for signaling of HVAC controller or security system
10. Vacancy only mode: Provide appropriate controls to ensure sensor will not turn lights on when someone enters room, but will turn lights off when they leave in areas designated as vacancy only or where required by law or local ordinance (ie. California Title 24).

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

D. XCT Type: Ceiling or wall mounted; detect occupants in coverage area using enhanced PIR and digital signal processing using Cross Correlation Technology to sense human motion vs. noise.
1. Sensitivity Adjustment: Adjust for each space type
2. Vacancy and Daylight Mode: Set occupancy, vacancy, or occupancy with low ambient daylight
3. Detection Coverage (enclosed rooms):
   a. 96" ceiling – 18’ x 18’ room size or maximum of 324 sqf
   b. 108" ceiling – 20’ x 20’ room size or maximum of 400 sqf
   c. 120" ceiling – 22’ x 22’ room size or maximum of 484 sqf
   d. 144" ceiling – 26’ x 26’ room size or maximum of 676 sqf
4. Detection Coverage (corridors):
   a. 6’ wide corridor – 50 feet length
   b. 8’ wide corridor – 100 feet length
   c. 10’ wide corridor – 150 feet length
2.6 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
5. Lightolier Controls.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSI Industries LLC; TORK Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric.
12. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

2.7 LIGHTING CONTACTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
5. Square D; a brand of Schneider Electric.
6. Lutron Electronics, Co., Inc.

B. Description: Electrically operated and mechanically held, combination-type lighting contactors, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
2. Control: On-off operation.

2.8 EMERGENCY SHUNT RELAY

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. Lighting Control and Design; Acuity Lighting Group, Inc.
2. Watt Stopper.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
1. Coil Rating: Match the circuit voltage

2.9 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION
A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies. Install per manufacturer’s instructions and reference warnings and installation guidelines for best practices.
B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION
A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION
A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION
A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
C. Perform the following tests and inspections:
   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Lighting control devices will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports.

3.6 ADJUSTING
A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations. Set vacancy or occupancy mode per owner's preference.
   2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
   3. Align high-bay occupancy sensors per manufacturer's instruction.

3.7 DEMONSTRATION
A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Division 26 Section "Network Lighting Controls."
B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION
SECTION 260933
CENTRAL DIMMING CONTROLS

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 microprocessor-based central dimming controls.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
   1. For central dimming controls; include elevation, features, characteristics, and labels.
   2. For dimmer panels; include dimensions, features, dimmer characteristics, ratings, and directories.
   3. Device plates, plate color, and material.
   4. Ballasts and lamp combinations compatible with dimmer controls.
   5. Sound data including results of operational tests of central dimming controls.
   6. Operational documentation for software and firmware.
B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
   1. Include elevation views of front panels of control and indicating devices and control stations.
   2. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.
B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For central dimming controls with remote-mounting dimmers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Software manuals.
   2. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
   3. Operation of adjustable zone controls.
   4. Testing and adjusting of panic and emergency power features.

1.6 MATERIALS MAINTENANCE SUBMITTALS
A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Dimmers: Full-size units equal to 10% percent of amount installed for each size indicated, but no fewer than 2 units.
   2. Fuses: Equal to 10% percent of amount installed for each size installed, but no fewer than 2.

1.7 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.
C. Comply with NFPA 70.

1.8 COORDINATION
A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:
   1. Division 26 Section "Lighting Control Devices."
1.9 COMMISSIONING
A. Provide factory-employed field service engineer to a site visit to ensure proper system installation and operation under following parameters:
   1. Qualifications for factory-employed field service engineer:
      a. Minimum experience of 2 years training in the electrical/electronic field.
      b. Certified by the equipment manufacturer on the system installed.
   2. Make a visit upon completion of installation of central dimming control system:
      a. Verify connection of power feeds and load circuits.
      b. Verify connection and location of controls.
      c. Energize processor panel and download system data program.
      d. Verify proper connection of panel links (low voltage/data) and address panel.
      e. Download system panel data to dimming/switching panels
      f. Check dimming panel load types and currents and remove by-pass jumpers.
      g. Verify system operation control by control, circuit by circuit.
      h. Verify proper operation of manufacturers interfacing equipment.
      i. Verify proper operation of manufacturers supplied PC and installed programs.
      j. Verify operation of PC modem and test dial-up access.
      k. Obtain sign-off on system functions.
      l. User to be trained on system operation.

1.10 MAINTENANCE
A. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
B. Make new replacement parts available for minimum of ten years from date of manufacture.
C. Provide factory-direct, toll-free technical support hotline 24 hours per day, 7 days per week leading directly to a technician.
D. Provide on-site service support within 24 hours anywhere in continental United States and within 72 hours worldwide except where special visas are required.
E. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

1.11 WARRANTY
A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of central dimming controls that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Damage from transient voltage surges:
         1) Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41B.
         2) Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41C.
   2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion including labor.

1.12 SOFTWARE SERVICE AGREEMENT
A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   1. Provide 30 days’ notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 REFER TO DRAWINGS.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION
A. Comply with NECA 1.
B. Wiring Method:
1. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 27 Section "Communications Horizontal Cabling."
C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION
A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" for identifying components and power and control wiring.

3.3 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
B. 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.
C. Tests and Inspections:
1. Continuity tests of circuits.
2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
   a. Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
3. Emergency Power Transfer: Test listed functions.
D. Remove and replace malfunctioning dimming control components and retest as specified above.
E. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
F. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.4 SOFTWARE SERVICE AGREEMENT
A. Technical Support: Beginning with Substantial Completion, service agreement shall include software support for two years.
B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.5 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central dimming controls.
B. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

END OF SECTION
SECTION 262416

PANELBOARDS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS
A. SVR: Suppressed voltage rating.
B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   7. Include wiring diagrams for power, signal, and control wiring.
   8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified testing agency.
B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
C. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
D. Panelboard Schedules: For installation in panelboards.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.
   2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

1.8 QUALITY ASSURANCE
A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency’s Field Supervisor: Currently certified by NETA to supervise on-site testing.
B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   E. Comply with NEMA PB 1.
   F. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 PROJECT CONDITIONS
A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).
C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Construction Manager’s written permission.
   3. Comply with NFPA 70E.

1.11 COORDINATION
A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.12 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets as indicated on Drawings.

1. Rated for environmental conditions at installed location.
   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Outdoor Locations: NEMA 250, Type 3R.
   c. [Retain one of first two subparagraphs below.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

3. Finishes:
   a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.


C. Phase, Neutral, and Ground Buses:


2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.


2. Main and Neutral Lugs: Mechanical type.

3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.


2.2 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.


4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.


E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.


2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and \( I^2t \) response.
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
   e. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.
B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
C. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
E. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
F. Install filler plates in unused spaces.
G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
I. Comply with NECA 1.

3.3 IDENTIFICATION
A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. 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.
D. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
E. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
F. Panelboards will be considered defective if they do not pass tests and inspections.
G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING
A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."
C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
3.6 PROTECTION
   A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION
SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Receptacles, receptacles with integral GFCI, and associated device plates.
      2. Snap switches and wall-box dimmers.
      4. Wall-switch and exterior occupancy sensors.
      5. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS
   A. EMI: Electromagnetic interference.
   B. GFCI: Ground-fault circuit interrupter.
   C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
   D. RFI: Radio-frequency interference.
   E. TVSS: Transient voltage surge suppressor.
   F. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
   C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS
   A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.7 QUALITY ASSURANCE
   A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   C. Comply with NFPA 70.

1.8 COORDINATION
   A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
      1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers’ Names: Shortened versions (shown in parentheses) of the following manufacturers’ names are used in other Part 2 articles:
      1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
      2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
      4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 5351 (single), 5352 (duplex).
      b. Hubbell; HBL5351 (single), CR5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).
      d. Pass & Seymour; 5381 (single), 5352 (duplex).
      e. Refer to Architectural Sheet A5.01 for Color.

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; TR8300.
      b. Hubbell; HBL8300SG.
      c. Leviton; 8300-SGG.
      d. Pass & Seymour; 63H.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. Cooper; GF20.
      b. Pass & Seymour; 2084.
      c. Hubbell; GF5352A.
      d. Leviton; 6898.

2.4 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2.5 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
      b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
      c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
      d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221PL for 120 V and 277 V.
      b. Hubbell; HPL1221PL for 120 V and 277 V.
      c. Leviton; 1221-PLR for 120 V, 1221-TPLR for 277 V.
      d. Pass & Seymour; PS20AC1-PLR for 120 V.
   2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 2221L.
      b. Hubbell; HBL1221L.
      c. Leviton; 1221-2L.
      d. Pass & Seymour; PS20AC1-L.
   2. Description: Single pole, with factory-supplied key in lieu of switch handle.
2.6 WALL-BOX DIMMERS
A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
   1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."
D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
E. LED dimmers tested/certified for use with LED drivers.

2.7 OCCUPANCY SENSORS
A. Refer to Drawings.

2.8 WALL PLATES
A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.9 FLOOR SERVICE FITTINGS
A. Refer to Drawings.

2.10 POKE-THROUGH ASSEMBLIES
A. Refer to Drawings.

2.11 MULTIOUTLET ASSEMBLIES
A. Refer to Drawings.

2.12 FINISHES
A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: Refer Architect finish schedule for device colors, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.
C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtailed.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailed existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtailed that are not less than 6 inches (152 mm) in length.
   5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
   6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtailed for device connections.
   8. Tighten unused terminal screws on the device.
   9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
   2. Install hospital-grade receptacles with the ground pin up or the neutral blade mounted to the right if mounted horizontally.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
   1. Install dimmers within terms of their listing.
   2. Verify that dimmers used for fan speed control are listed for that application.
   3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers’ device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION
A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL
A. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION
SECTION 262813

FUSES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Cartridge fuses rated 600-V ac and less for use in enclosed switches.
2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   4. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.6 QUALITY ASSURANCE
A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with NEMA FU 1 for cartridge fuses.
D. Comply with NFPA 70.
E. Comply with UL 248-11 for plug fuses.

1.7 PROJECT CONDITIONS
A. Where ambient temperature to which fuses are directly exposed to more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.
1.8  **COORDINATION**  
A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

**PART 2 - PRODUCTS**

2.1  **MANUFACTURERS**  
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.

2.2  **CARTRIDGE FUSES**  
A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3  **SPARE-FUSE CABINET**  
A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
   2. Finish: Gray, baked enamel.
   3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
   4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

**PART 3 - EXECUTION**

3.1  **EXAMINATION**  
A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2  **FUSE APPLICATIONS**  
A. Cartridge Fuses:
   1. Motor Branch Circuits: Class RK5, time delay as required.
   2. Control Circuits: Class CC, time delay.

3.3  **INSTALLATION**  
A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.
C. Install spare-fuse cabinet(s).

3.4  **IDENTIFICATION**  
A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

**END OF SECTION**
SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Enclosures.

1.3 DEFINITIONS
A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers’ technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of NRTL listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified testing agency.
B. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
C. Manufacturer’s field service report.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer’s written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.
1.8 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Member company of NETA or an NRTL.
      1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
   B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
   C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
   D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   E. Comply with NFPA 70.

1.9 PROJECT CONDITIONS
   A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

1.10 COORDINATION
   A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES
   A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
      1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      4. Square D; a brand of Schneider Electric.
   B. Type HD, Heavy Duty, Single Throw, voltage as required ac, 1200 A and Smaller where indicated on drawings: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
   C. Accessories:
      1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
      2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
      3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
      4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
      5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES
   A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
      1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      4. Square D; a brand of Schneider Electric.
   B. Type HD, Heavy Duty, Single Throw, voltage as required ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
   C. Accessories:
      1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS
A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.
B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
E. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.4 ENCLOSURES
A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Install fuses in fusible devices.
E. Comply with NECA 1.

3.3 IDENTIFICATION
A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

E. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING
A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION
SECTION 263323

CENTRAL BATTERY EQUIPMENT

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes central battery inverters.

1.3 ACTION SUBMITTALS
   A. Product Data: For the following:
      1. Electrical ratings, including the following:
         a. Capacity to provide power during failure of normal ac.
         b. Inverter voltage regulation and THD of output current.
         c. Rectifier data.
         d. Transfer time of transfer switch.
         e. Data for specified optional features.
      2. Transfer switch.
      3. Inverter.
      4. Battery charger.
      5. Batteries.
      7. Battery-cycle warranty monitor.
   B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
      1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring.
      2. Elevation and details of control and indication displays.
      3. Output distribution section.

1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For testing agency.
   B. Source quality-control test reports.
   C. Field quality-control test reports.
   D. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For central battery inverter equipment to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
      1. Fuses: One for every 10 of each type and rating, but no fewer than 2 of each.
      2. Cabinet Ventilation Filters: One complete set.
      3. One spare circuit board for each critical circuit.

1.7 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Member company of the InterNational Electrical Testing Association or is an NRTL.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   C. Comply with NFPA 70 and NFPA 101.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Deliver equipment in fully enclosed vehicles.
B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.9 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion: One year.

PART 2 - PRODUCTS

2.1 REFER TO DRAWINGS

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install system components on concrete base and attach by bolting.

1. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.

2. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems.”

3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

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 Division 03 Section.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS
A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems.”

1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables.”

3.4 IDENTIFICATION
A. Identify equipment and components according to Division 26 Section "Identification for Electrical Systems.”

3.5 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. 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.

D. Tests and Inspections:
1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
2. Test manual and automatic operational features and system protective and alarm functions.
3. Test communication of status and alarms to remote monitoring equipment.
4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace malfunctioning units and retest as specified above.

3.6 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.
B. Verify that central battery inverter is installed and connected according to the Contract Documents.
C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
D. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING AND CLEANING
A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
B. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.

3.8 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 264313
SURGE PROTECTIVE DEVICES (SPDs) FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes Surge Protection Devices (SPD) for low-voltage power, control, and communication equipment.
B. Related Sections include the following:
1. Division 26 Section "Wiring Devices" transient voltage surge suppressors.
2. Division 26 Section "Panelboards"
3. Division 26 Section "Switchboards"

1.3 SUBMITTALS
A. Must have ten day prior approval to bid on project. Request for submittal must be in writing and attached with independent documentation of the following items.
B. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, mounting provisions, connection notes, wire size and wiring diagram.
C. Equipment Manual: The manufacturer shall furnish an installation manual with installation notes, start-up and operating instructions for the specified system. Installation instructions shall clearly state whether the system requires an external overcurrent device to maintain the system's UL 1449 listing. SPD requiring external overcurrent devices are not acceptable.
D. VPR (clamping voltage) rating under UL 1449 3rd edition 6kV x 3000A testing will be a maximum of the following:
   1. 120V system  700V (L-N)
   2. 277V system  1200V (L-N)

1.4 STANDARDS
A. Underwriters Laboratories 1449 - (UL 1449 3rd edition or current safety standard for surge protection devices – 2009)
B. NEC article 285. National Electrical Code 2008 and NFPA 780 Standard for the installation of lightning protection systems. SPD shall be labeled with a minimum 100kAIC rating.
C. IEEE (Institute of Electrical and Electronic Engineering Inc.) C62.41.1 and C62.41.2 – 2002
   IEEE C62.45 – 2002
   IEEE C62.33 & C62.35
D. All manufacturers must comply with above listed standards and any additions current revisions of industry standards. All products that do not comply with current industry standards will not be accepted.

1.5 QUALITY ASSURANCE
A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer. Product are manufactured or produced in the United States.

1.6 PROJECT CONDITIONS
A. Placing into Service: Do not energize or connect service entrance equipment, panelboards, control terminals, or data terminals to their sources until the surge protective devices are installed and connected.
B. Protection modes: The SPD shall provide Line to Neutral (L-N) (Wye), Line to Ground (L-G) (Wye or Delta), Line to Line (L-L) (Delta) and Neutral to Ground (N-G) (Wye) protection.
C. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
   1. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent of nominal system operating voltage per UL 1449 3rd.
   2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
   3. Humidity: 0 to 85 percent, non-condensing.
4. Altitude: Less than 20,000 feet (6000 m) above sea level.

1.7 COORDINATION
A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

1.8 WARRANTY
A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
B. Manufacturer shall provide a product warranty for a period of not less than ten (10) years from date of installation. Warranty shall cover unlimited replacement of SPD module or modules during the warranty period. Those firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of SPDs for not less than five (10) years.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers
A. General Electric
B. Siemens
C. Square D
D. Eaton

2.2 SERVICE ENTRANCE SUPPRESSORS
A. Required surge current ratings per phase:

<table>
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<th>Service Entrance</th>
<th>≥3,000A</th>
<th>2500-1600A</th>
<th>1200-800A</th>
<th>600A</th>
<th>400-100A</th>
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<td>200 kA</td>
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<td>200 kA</td>
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<td></td>
<td>100 kA</td>
<td>100 kA</td>
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</tbody>
</table>

B. Equipment shall be a multi-stage parallel protector. All voltages must be verified by location on drawings, one-line diagrams and equipment scheduled. The equipment's minimum surge current capacity shall be as shown above depending upon panel amperage.
C. SPD shall be modular design with field replaceable module or modules. Redundant status indicators shall be mounted on the front of the door that monitors the system protection circuitry.
D. SPD shall contain a technology that utilizes multiple thermally protected metal oxide varistors (MOV) per mode.
E. SPD shall be labeled as minimum with Type 1 if installed ahead of the service entrance disconnect or Type 2 if installed downstream of the service entrance disconnect (verifiable at UL.com). Every component of every mode, including N-G, shall be protected by internal thermal protection. SPDs relying upon external or supplementary installed safety overcurrent protection do not meet the intent of this specification. Units must have an In (nominal discharge) of 20kA.
F. SPD shall provide the following monitoring features and options: dry contacts, surge counter and audible alarm. Equipment shall utilize a NEMA 4 enclosure.

2.3 DISTRIBUTION PANELS
A. Device shall meet all specification requirements in section 2.1 except as follows:
   Equipment shall be a multi-stage parallel protector. All voltage must be verified by location on drawings, one-line diagrams and equipment scheduled. The equipment's minimum surge current capacity shall be 200kA per phase (L-N plus L-G) and 100kA per mode (L-N, L-G, L-L and N-G).
   1. The system protection shall contain metal oxide varistors (MOV). Each MOV will be individually coordinated to pass UL 1449. The unit shall be non-modular or modular type.
   2. Equipment shall provide the following monitoring features: dry contacts and audible alarm. Equipment shall utilize a NEMA 4 enclosure.

2.4 BRANCH PANEL SUPPRESSORS & AUXILIARY PANEL SUPPRESSORS
A. Device shall meet all specification requirements in section 2.2 except as follows:
Equipment shall be a multi-stage parallel protector. All voltage must be verified by location on drawings, one-line diagrams and equipment scheduled. The equipment’s minimum surge current capacity shall be 100kA per phase (L-N plus L-G) and 50kA per mode (L-N, L-G, L-L and N-G).

1. The system protection shall contain metal oxide varistors (MOV). Each MOV will be individually coordinated to pass UL 1449. The unit shall be non-modular or modular type.

2. Equipment shall provide the following monitoring features: dry contacts and audible alarm. Equipment shall utilize a NEMA 4 enclosure

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. Review all installation information in owners manual. Verify all voltage before connections to avoid injury and damage to equipment. The specified unit shall be installed external to switchboard, distribution and panelboard as stand alone. Internal products will not be accepted.

B. The specified service entrance/switchboard/switchgear system shall be installed with the shortest lead length possible from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.56) or less and shall avoid any unnecessary or sharp bends.

C. The specified distribution and branch panelboard system shall be installed with the shortest lead length possible from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.56) or less and shall avoid any unnecessary or sharp bends.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.

2. Inspect anchorage, alignment, grounding, and clearances.

3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

4. Before energizing, installer shall verify service and separately derived system Neutral to Ground bonding jumpers per NEC.

B. A SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION
PART 1 - GENERAL

1.1 GENERAL CONDITIONS AND DEFINITIONS

A. Scope: This specification section applies to all Division 27 specification sections and all Division 28 specification sections with the exception of Fire Alarm. All systems under the specifications indicated above are referenced also in this contract documents as “technology systems”.

B. Scope of work is limited to providing raceways, conduits, and back boxes for installation of the system. Communication design and wiring by owner.

C. Drawings and specifications: The words “drawings” and “specifications” used on this section refer to all contract drawings and specifications describing the scope of work of the technology system.

D. Installer and Contractor: The word “installer” where used on the drawings or specifications without any further description shall reference the installer of the system under reference. The word “contractor” where used on the drawings or specifications without any further description shall reference to the General Contractor (or Construction Manager) holding the prime agreement with the owner for the construction of this project.

E. Provide and Install: The word, “provide” where used on the drawings or specifications shall mean, “furnish, install, mount, connect, test, complete, document and make ready for operation”. The word “install” where used on the drawings or specifications shall mean, “mount, connect, test, complete, and make ready for operation”.

F. The word Engineer (also referenced as A&E) where used on the drawings or specification refers to the design engineer of the project working for the project architect or the owner. It does not refer to an engineer working for the General contractor, Construction Manager or any of the installers in the project.

G. Complete systems: All technology systems are intended to be complete systems, including all materials and labor to install raceways of the system.

H. Active equipment: Active equipment is defined as equipment composed of electronic component and electric materials, design to work with power applied to it. Cables are not considered active equipment.

1.2 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

A. Objective: The intent of the design drawings and specifications is to provide the installer of a technology system a scope of work for bidding purposes and to make sure different bids received by the entity holding the bidding for the technology system are at the same level of scope for comparison purposes. The drawings and specifications are not intended to show every single element of the project to produce a buyout list for the installer. In general, for all technology systems, all active components are specifically called out but small wires and small installation materials (such as nut, bolts, washers, termination blocks, clamps, ties, etc) are not indicated in the documents. Guidelines for installation of those systems are provided in the specification to allow the installer to produce the complete buyout list of materials.

B. Accuracy: The Drawings are diagrammatic and are not intended to show exact locations of conduit runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, conduits, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Architect or Engineer during construction. Obtain in the field all information relevant to
the placing of technology systems work and in case of interference with other work, proceed as directed by the Architect or Engineer.

C. Distances: Although most drawings have a scale referenced on each sheet, the drawings are a two dimensional representation of the system, so design drawings do not indicate changes in elevation that cause additional lengths and quantities of materials. It is the responsibility of the installer of each technology system to field verify all distances before bidding to properly estimate all cable Conduit distances and materials.

D. Discrepancies: Notify the A&E of any discrepancies found during construction of the project and do not proceed with that portion of the project, until a written definitive statement is received providing clear direction. If a conflict exists between the contract documents and any applicable code or standard, the most stringent requirement shall be included for this project. The Engineer shall make the decision regarding questionable areas of conflict.

E. Existing Conditions: All existing conditions might not be indicated in the design drawings. The installer of each system shall check site and existing conditions thoroughly before bidding and advice the Engineer of discrepancies prior to bid.

F. Coordination: Although design technology drawings were intended to be coordinated with other trades, the fact that installer for other non-technology system might have changes to their design drawings, requires the Contractor to produce coordination drawings for a specific space, including all elements of all trades for space planning and coordination purposes.

1.3 ABBREVIATIONS

A. Abbreviations: The following abbreviations or initials may be used:
1. ABV CLG - Above Ceiling
2. AC - Alternating Current
3. ADA - American Disabilities Act
4. AFF - Above Finished Floor
5. AFG - Above Finished Grade
6. AMP - Ampere
7. ANSI - American National Standards Institute
8. AWG - American Wire Gauge
9. BC - Bare Copper
10. CCTV - Closed Circuit Television
11. CATV - Community antenna television
12. CLG - Ceiling
13. COAX - Coaxial Cable
14. CPU - Central Processing Unit
15. DC - Direct Current
16. DEG - Degree
17. EMT - Electrical Metallic Tubing
18. GND - Ground
19. IDF - Intermediate Distribution Frame (Telecom Room)
20. IMC - Intermediate Metallic Conduit
21. IN – Inches
22. IP - Internet Protocol
23. JB - Junction Box
24. KVA - Kilo-Volt-Amps
25. KW - Kilowatts
26. LBS - Pounds
27. LED - Light Emitting Diode
28. MAX - Maximum
29. MDF - Main Distribution Frame (Main Telecom Room)
30. MIC - Microphone
31. MIN - Minimum
32. MTD - Mounted
1.4 CODES AND STANDARDS

A. Application: The codes, standards and practices listed herein generally apply to the entire project and all technology systems. Other codes, standards or practices that are more specific will be referenced within a particular specification.

B. Requirements: All articles, products, materials, fixtures, forms or types of construction covered in the specifications will be required to meet or exceed all applicable standards of manufacturer, testing, performance, capabilities, procedures and installation according to the requirements of ANSI, NEMA, IEEE, NEC, BICSI and TIA referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents which exceed but are not contrary to governing codes shall be followed.

C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed technology system installation shall be inspected and certified by all applicable agencies that it is in compliance with all codes.

D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements. List of applicable codes:
   1. State of Texas.
   2. Denton County
   3. Town of Flower Mound

E. UL Labels: All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Communication Testing Agency. No equipment shall be installed if there is no labeling or listing service is available for such equipment.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. Definitions:
   1. Basis of design: A product or group of products from an identified manufacturer that was used as the basis of systems layouts and installation details, part of the contract documents.
   2. Prototype: Is a product or a group of products that are not yet ready for commercial use because they are in the testing phase (Beta testing) of the product development.
   3. Alternates: Products or manufacturers listed in the contract documents as acceptable compare to the basis of design. Use of alternates shall follow the same system architecture as the basis of design.
   4. Obsolete: A product that has been discontinued by the manufacturer or declared in end of life, and it is no longer being manufactured.
5. Substitution: A product not listed in the contract documents but capable of similar characteristics as the basis of design operating as a direct replacement in the system in reference. The installers can propose a substitution if all requirements are met as indicated in this specification.

6. Substitutions that create a change in system architecture are products that create a very different system configuration impacting other trades (i.e. change in power/cooling requirements, changes in raceways layout or sizes, changes in equipment space requirements, changes in low voltage wiring layouts, types and quantities, etc) but providing a similar end result as the system/products basis of design.

B. Use of Prototype. Prototypes are not allowed in any technology system.

C. Use of alternates. Alternates are allowed and installer shall follow these requirements:
   1. Where several brand names make or manufacturers are listed as acceptable alternates each shall be regarded as equally acceptable, based on the design selection. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where three or more manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance.
   2. The use of alternate products does not allow the change of system architecture with such products.

D. Use of substitutions. Substitutions are only allowed when they meet all the requirements below:
   1. Substitutions are only allowed when a particular specification section for a technology system, allows the use of substitutions for that particular system.
   2. The performance of all substitutions components must meet or exceed those of the basis of design. Should an installer wish to submit a substitution product or a product set stated in the construction documents as 'acceptable', it shall be the responsibility of the installer to submit to the Engineer an item-for-item CROSS REFERENCE for all specifications of the product, all related specifications and product data sheets, for the proposed substitution. Use the substitution request form indicated in Addendum 1 of this specification.
   3. The Engineer has the authority to reject a substitution without cause and the installer shall provide the basis of design and no additional compensation.
   4. Substitutions of unnamed manufacturers will not be acceptable.
   5. Certification of substitutions: When a basis of design is specified to be in accordance with a trade association or government standard requested by the Engineer, installer shall provide a certificate that the substitution complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
   6. Substitutions that create a change in system architecture are allowed under the following conditions:
      a. Substitution request for this type of system requires submitting the overall cost of substitution including the cost of changing other systems affected as well as the re-design cost for such systems. Without this information this type of substitution will not be evaluated at all.

1.6 SHOP DRAWINGS AND SUBMITTALS

A. General: Shop drawings shall be submitted for equipment and material as indicated in the individual specification sections for each system.

B. Quantity of shop drawings submittals: Follow Division 1 requirements for quantity of shop drawings and submitting requirements. If the project does not have a Division 1 specification, shop drawings shall be submitted in quantity of one (1) for electronic format submittal and quantity of four (4) for hardcopies.

C. Electronic submittals. Submittals in electronic format (PDF) are accepted.

D. When cut sheets of products are submitted and the manufacturer cut sheets indicate several model numbers or variations of the same product, the cut sheet shall be highlighted by the installer to indicate the specific product that will be provided for this project. Submittals received with cut sheets indicating multiple parts numbers and not highlighted will be rejected and not reviewed.
E. Equipment and material quantities are not reviewed by the A&E as part of this submittal process. Equipment quantities are to be provided by the installer as indicated in contract documents. Approved shop drawings indicating any changes in equipment quantities or overall scope of work different from contract documents does not constitute approval by the A&E of those changes. The contract documents and any changes issued by the A&E in the form of Supplemental Information during the construction process are always to be followed for equipment quantities and scope of work.

F. All electronic equipment prone to obsolescence and with lead times less than 3 months shall be submitted for approval no sooner than 12 months before the date set for substantial completion of the project. Electronic equipment prone to obsolescence includes devices like flat panel displays, transceivers, servers, players, workstation and routers.

G. Equipment and materials installed not in accordance with the approved shop drawings shall be replaced at installer’s expense.

H. Multiple stages of shop drawings shall be required as indicated in each specification section. For final completion and testing the installer shall provide a submittal with the following information:
1. Detailed course syllabus for each type of training required in the specifications
2. A proposed schedule of training sessions in compliance with the specification sections and indicating place where the training will take place.
3. A copy of all training material to be used during each session.
4. Test result sheets for all testing done by the installer prior to the system acceptance test.

PART 2 - PRODUCTS

2.1 IDENTIFICATION AND LABELING TAGS

A. All conduit, cabinets, cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified with pre-printed labels or tags.

B. The only approved types of labels for inside premise environments for any technology systems are:
1. Non-laminated thermal transfer labels, printed with a high quality thermal transfer printer.
2. Laminated thermal transfer labels printed with a high quality thermal transfer printer.
3. Thermal transfer polyolefin tape printed with a high quality thermal transfer printer.
4. Self laminated dot-matrix labels, printed with a high quality dot matrix printer.
5. Non-laminated dot-matrix labels, printed with a high quality dot matrix printer.

C. For labeling of cables or equipment in outdoor environments use only marker plates attached to cable or equipment with cable ties. Do not use any labels with adhesive materials. Use different color plates for different cable types. Use only waterproof ink for writing on marker plates.

D. Any type of write-on labels (except for outdoor marker plates), hand writing on cable jackets or directly on equipment, labels made with masking tape or any other type of tape not listed in previous paragraph are not acceptable and shall be corrected with approved labeling methods at no additional cost to the owner.

E. Approved manufacturer:
1. Rhino,
2. Brady,
3. Panduit or approved equal

2.2 TECHNOLOGY EQUIPMENT AND MATERIALS

A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacturer of the type and size of equipment, shall be suitable for the environment in which it is to
be installed, shall be approved for its purpose, environment, and application, and shall bear a label as indicated in paragraph 1.4.E. of this section.

B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer and the contract documents.

C. Required Accessories: All equipment specified in the technology systems shall be provided with all required accessories for proper operation and mounting. Typically these accessories are not specifically indicated in the design drawings but shall be provided per this specification section. Such accessories include items such as power supplies, power cords, rack ears, rack rails, bolts, lugs, faceplates, etc.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. WORKMANSHIP: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.

B. STANDARD OF QUALITY: To define good workmanship, all installation practices described in BICSI standards shall be followed.

C. PROTECTION OF EQUIPMENT: Equipment for Technology systems shall at all times during construction be adequately protected against mechanical/chemical damage by the elements or work perform by other trades. Equipment shall be stored in dry permanent shelters. If equipment or materials has been damaged, such equipment shall be replaced at no additional cost or time extension to the Contract. Damaged equipment and materials include the following conditions:

1. Equipment that has visible scratches, cracks or equipment that has paint or finished surface peeled off.
2. Equipment with visible indication of rust or water intrusion.
3. Equipment that has dents on the metal enclosures and are clearly visible to the end user.
4. Equipment that has been sprayed with paint, fire proofing materials, or other type of chemicals, when the equipment was not intended to have this type of materials applied to it, per contract documents.
5. Equipment that has been burnt by controlled fires, power surges, power sags or by lightning.
6. Equipment that has a known damage to any parts, electronic board or component, even if such component or board has no specific use in the project.
7. Cables that have visible damages to the jackets even if cables are not broken and still provide electrical continuity.
8. Cables sprayed with paints that affect the warranty of the cable as defined by the cable manufacturer.
9. Equipment with screws with stripped heads.

D. CLEAN EQUIPMENT: All equipment installed in spaces accessible to the building occupants like in racks, cabinets, wall mounted panels, credenzas, etc. shall be free of dust at the time the space part of the project gets the final Certificate of Occupancy and at the time of the acceptance test by the A&E. A clean equipment is defined as an equipment that if wiped with a finger, in any surface, does not leave visible debris and dust in the finger, also equipment with no visible signs of dust inside the equipment, like in ventilation fans..

E. IDENTIFICATION AND TAGGING: All technology systems items shall be labeled and identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system which it serves or controls. Refer to Identification Section of the specifications for additional information. All labels of equipment and wiring shall match the labeling used in the shop drawings for the system.
3.2 COORDINATION

A. General: The installer shall compare shop drawings with those of other trades and report any conflicts between them to the A&E. Obtain from the A&E written instructions to make the necessary changes in any of the affected work. All work shall be installed in cooperation with other Trades installing interrelated work.

B. Adjustments: Locations of conduit and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of all systems prior to fabrication or installation.

C. Replacement: All work shall be installed in a way to permit removal (without damage to other parts) of all other system components provided under this Contract requiring periodic replacement or maintenance. All conduits shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.

3.3 TELECOM ROOM/EQUIPMENT ROOM READINESS

A. In any projects where the technology systems require the use of network equipment (switches, routers, firewalls, etc) provided by the owner, the Contractor shall complete all telecom rooms to a point where they are suitable for the owner to deploy such equipment in those rooms. At a minimum the following conditions shall be meet at all rooms in order for the owner to install the equipment:

1. All power outlets in the telecom rooms shall be feed from the permanent source of power. Temporary power shall not be provided.
2. The mechanical equipment providing the cooling for the telecom rooms shall be fully operational. Temporary cooling shall not be accepted.
3. Fire suppression system (sprinkler or gas based system) protecting the telecom rooms shall be fully operational and tested.
4. All light fixtures in the telecom rooms shall be fully operational.
5. All walls to the telecom rooms shall be completed and including the last coat of paint.
6. The ceiling and flooring of the telecom rooms shall be finished.
7. All horizontal and backbone cabling system part of the structured cabling system (SCS) shall be installed, terminated and tested.
8. The final and permanent doors to the telecom rooms shall be installed with a key core different from all other construction cores in the site.
9. Telecom rooms shall be cleared of any materials being stored inside the room.
10. Telecom rooms shall be clean. Clean will be measured as not having any debris left in the room and not having dust in rack, cabinets, or wall mounted panels. If wiping a finger in any of the surfaces of such equipment leaves visible dust residue in the finger, the room will not be considered clean.
11. Hallways and rooms leading into the telecom rooms shall have no more sanding to be done in the walls and the floor shall be completed to avoid dust from these spaces moving into the telecom rooms.
12. Prior to the owner deploying the equipment in these rooms, the Contractor shall provide disposable sticky mats at the entrance of each telecom room to capture dust and/or dirt from people’s shoes or boots coming into the room. The sticky mats shall be selected as to cover the width of the door opening. Sticky mats shall contain no less than 60 sheets in each unit. Used sheets of the mats shall be replaced no less than on a daily basis or if worn out before the end of the day. Sticky mats shall be provided until the project receives the final Certificate of Occupancy.

13. END OF SECTION
SECTION 270526
GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section.
B. General: For grounding electrode system and equipment grounding system for Telecommunications refer to specification section 260526. In all cases the applicable electrical codes for grounding and bonding for telecommunications shall be met.
C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.

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D. General. For a bonding diagram for telecommunications refer to T Drawings.
E. General. The bonding approach required herein is intended to work in concert with the cabling topology as specified in Specification section 271000 and installed in accordance with specification section 270528.
F. Reference Standards:
   1. TIA-607-A
   2. TIA-607-B
   3. TIA-568-C
   4. TIA-606
   5. UL 1863 Communication Circuit Accessories
   6. UL-50 & UL-514
   7. NFPA 70 – NATIONAL ELECTRIC CODE
   10. UL 1449
   11. NFPA 780

1.2 MATERIALS ALTERNATES AND SUBSTITUTIONS
A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

1.3 SHOP DRAWINGS AND SUBMITTALS
A. See additional requirements for shop drawings and submittals in specification section 270010.
B. The installer of the Telecommunications Grounding systems shall provide the following information in the shop drawings phase of the project:
   1. Manufacturer’s cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
   2. A spreadsheet indicating telecommunications ground bar information selection for each telecommunications room indicated in the design drawings, including the following information:
      a. Room Name or number
      b. Quantity of ground bars
      c. Height of each ground bar
      d. Length of each ground bar
      e. Number of holes in each ground bar
   3. A drawing indicating the following information:
      a. Location of all telecommunications ground bars and routing of all telecommunications grounding backbones.
      b. Wire size charts for all telecommunications grounding backbones in the project.
c. All labels to be used in telecommunications backbone cables, bonding conductors and telecommunications ground bars.

1.4 ABBREVIATIONS
A. General: The following abbreviations are used in this specification section:
   TBB - Telecommunications Bonding Backbone
   1. BC - Bonding Conductor
   2. EMT - Electrical Metallic Tubing
   3. RMC - Rigid Metal Conduit

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)
A. The TMGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB shall be located and provided in the Main Telecommunication Room in each building. The TMGB must also be listed by a nationally recognized testing laboratory (NRTL).
B. The TMGB shall have the following specifications:
   1. Material: Copper with a thin plated finish.
   2. Thickness: ¼” thick
   3. Width: No less than 4”
   4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 14” long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
      Two holes required for each TBB termination.
      a. Two holes for each cabinet or rack row in the room
      b. Two holes for each protector block in the room
      c. Two holes for each layer of ladder tray above the rack.
      d. Two holes for each set of conduit sleeves entering the room
      e. 20% of spare capacity shall be available after all terminations are done.
      f. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.
      Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16”
   5. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.
C. The TMGB shall be installed in the wall with stand-offs and isolators. Isolators shall be rated at 600V.
D. Approved manufacturers:
   1. Panduit,
   2. Erico or
   3. approved equal.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR INTERIOR USE
A. The TGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TGB shall be located and provided in each telecommunication room (except the main telecommunication room) in each building and any other additional locations as indicated in the drawings. The TGB must also be listed by a nationally recognized testing laboratory (NRTL).
B. The TMGB shall have the following specifications:
   1. Material: Copper with a thin plated finish.
   2. Thickness: ¼” thick
   3. Width: No less than 4”
   4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 12” long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
      Two holes required for each TBB termination.
      a. Two holes for each cabinet or rack row in the room
      b. Two holes for each protector block in the room
      c. Two holes for each layer of ladder tray above the rack.
      d. Two holes for each set of conduit sleeves entering the room
   5. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.
e. 20% of spare capacity shall be available after all terminations are done.
f. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.

5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16”
6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.

C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.

D. Approved manufacturers:
1. Panduit,
2. Erico or
3. approved equal.

2.3 FLEX CONDUCTOR, ONE-HOLE, LONG BARREL WITH WINDOW LUG
A. All BCs (different from TBB) shall be terminated in a flex conductor, one hole, long barrel with window lug when a two hole connector is not possible to be used because receiving equipment does not support the two holes. All lugs shall be selected to match the size of the conductor being used. Other types of terminations such as screw type connectors are not accepted.

B. The flex conductor, one hole, long barrel with window lug shall have the following specification:
   1. Finish: Thin plated
   2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
   3. Stud hole size: ¼”
   4. Barrel type: Long barrel > 1”
   5. Termination type: crimp type
   6. Angle: straight or angled if installation space is limited.
   7. Listing: UL listed and tested to 35 KV and 90ºC

C. Approved manufacturers: Panduit, Thomas & Betts or approved equal.

2.4 FLEX CONDUCTOR, TWO HOLE, LONG BARREL WITH WINDOW LUG
A. Flex conductors, two hole, long barrel with window shall be used with TBB and BCs to provide a good bond. All lugs shall be selected to match the size of the conductor being used. Other types of terminations are not accepted.

B. The flex conductor, two hole, long barrel with window lug shall have the following specification:
   1. Finish: Thin plated
   2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
   3. Stud hole size: ¼”
   4. Hole spacing: to match spacing of pre-drilled holes in ground bar or equipment.
   5. Barrel length: long barrel > 1”
   6. Termination type: crimp type
   7. Angle: straight or angled if installation space is limited.
   8. Listing: UL listed and tested to 35 KV and 90ºC

C. Flex conductors, two hole, long barrel with window shall be used with BCs in the following cases:
   1. Bonding two sections of pathways such as sections of tubular runways or cable trays.
   2. Bonding a BC or a TBB to a TGB or TMGB
   3. Bonding to equipment that requires two holes for bonding.

D. Approved manufacturers:
   1. Panduit,
   2. Thomas & Betts or
   3. approved equal.

2.5 HTAP CONNECTOR
A. When a BC is required to be bonded to another BC of same or different size the only approved method of bonding is with HTAP style crimp connectors. Screw type connectors, wire nuts or any other method are not acceptable. The specifications of the HTAP connectors are:
   1. Finish: Thin plated
   2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
   3. Tap grooves: installer to select HTAP connector based on size of BCs and quantity of BCs to be bonded.
   4. Slots: The HTAP connector shall have a lot to support the unit to the bonding conductors with nylon cable ties for initial support before crimping.
5. Termination type: crimp type
6. Listing: UL listed and tested to 600V
B. Approved manufacturers:
   1. Panduit,
   2. Thomas & Betts or
   3. approved equal.

2.6 TELECOMMUNICATIONS BONDING BACKBONE (TBB)
A. Telecommunications bonding backbones shall be provided as indicated in the design documents. TBBs shall be #4/0 AWG insulated copper grounding conductor.

2.7 BONDING CONDUCTOR (BC)
A. Bonding conductors shall be used to bond equipment and raceways to the telecommunications grounding infrastructure. The specifications of the BC are:
   1. Conductor Size: #4/0 AWG.
   3. Insulation: Use non-insulated conductors only under raised floor spaces. Insulation color shall be green with a yellow stripe.
B. Pre-fabricated BCs or field made BCs are acceptable.
C. Both ends of a BC shall be terminated in long barrel lugs.

2.8 LABELS FOR TELECOMMUNICATIONS GROUNDING INFRASTRUCTURE
A. Installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES.
A. General: Specification section 260526 applies to work of this section. Installation requirements specified herein takes precedence over specification section 260526.
B. General: All installation requirements indicated in specification section 270010 shall be followed.
C. PROTECTION. The TBBs and BCs shall be installed and protected from physical and mechanical damage.
D. GALVANIC CONTINUITY. The TBBs and BCs shall be continuous and routed in the shortest possible straight line path.
E. CRIMPING. All lugs shall be crimped with the proper die for the size of lug being used.
F. PAINT REMOVAL. Paint shall be removed before attaching any BC to an equipment with paint in the surface, such as ladder trays and racks, if no ground lug is available in the equipment.
G. SPLICING. The TBBs and BCs shall be installed without splices. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located within telecommunications spaces. Joined segments of a TBB or BC shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.
H. BONDING TO ELECTRICAL PANELS. The TGB or TMGB shall be as close to the electrical power panel as is practicable and shall be installed to maintain clearances required by applicable electrical codes. The electrical power panel bus or the panel enclosure feeding telecommunications equipment racks/cabinets shall be bonded to the TGB or TMGB.
I. BONDING TO BUILDING STEEL. All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose.
J. LUG SCREWS. All connections from lugs to ground bars or grounding equipment shall be done with metal screws with nuts and compression washers. Connections made with metal self tapping screws will not be allowed.
K. BONDING PROTECTOR BLOCKS. All primary or secondary building entrance protectors blocks shall be bonded to the nearest TMGB or TGB with a BC. A minimum of 300 mm (1 ft) separation shall be maintained between this insulated conductor and any dc power cables, switchboard cable, or high frequency cables, even when placed in rigid metal conduit or EMT.
L. BONDING OUTSIDE PLANT CABLES. When the outside plant cables in the Telecommunications Entrance Facility room incorporate a cable metallic shield (armor) isolation gap, the cable metallic shield on the building side of the gap shall be bonded to the TMGB or TGB or the rack/cabinet or the rack’s vertical ground bar (if available).
M. BONDING BACKBONE CABLES. Where backbone cables (fiber or copper) incorporate a shield (armor) or metallic member, this shield or metallic member shall be bonded to the TMGB or TGB or rack/cabinet or the rack’s vertical ground bar (if available).

N. BONDING HORIZONTAL CABLES. When shielded horizontal cable is used and terminated in patch panels, each patch panel needs to be bonded to the telecommunications grounding systems. A BC shall be used between each patch panel and the rack rails of the rack/cabinet or the rack’s vertical ground bar (if available).

O. INTENDED USE OF TBB OR BC. The TBB or BC is not intended to serve as the only conductor providing a ground fault current return path. The intended function of the TBB or BC is to equalize potential differences between telecommunications systems.

P. INSTALLATION OF TBBs INSIDE TELECOMMUNICATIONS SPACES. When TBBs are run inside telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs inside telecommunications spaces can be made of PVC and shall be sized and supported as required by NEC.

Q. INSTALLATION OF TBBs OUTSIDE TELECOMMUNICATIONS SPACES. When TBBs are run outside of telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs outside telecommunications spaces shall be EMT or RMC. To avoid an electromagnetic choke effect in this conductor, each end of the conduit used to protect the TBB shall be bonded to the TMGB or TGB at each end. Conduit used for protection of TBBs shall be sized and supported as required by NEC.

R. RACK/CABINET BONDING. All racks/cabinets in the project shall be bonded to the nearest TMGB or TGB inside the room. All rows of rack/cabinets shall be bonded together by a single AWG-2 conductor coming from the nearest TMGB or TGB inside the room. This bonding conductor shall be insulated and run above the racks in the side of the cable tray system, going above the racks, supported by a hanger external to the cable tray. At each rack a bonding jumper (AWG-6) shall be provided and terminated to the rack manufacturer’s recommended lug for bonding the rack/cabinet. The bonding jumper shall be connected to the AWG-2 conductor by means of an HTAP connector, protected with heat shrink material. When the project requires R56 grounding compliance, the bonding jumper shall be upsized to an AWG-2 and a vertical ground bar shall be provided for each rack/cabinet from top to bottom of each rack/cabinet. This ground bar shall be the termination point for the bonding jumper for each rack and shall also bond the manufacturer’s approved grounding lug in the rack/cabinet to the ground bar.

S. RACK/CABINET BONDING OUTSIDE OF TELECOM ROOMS. Racks/cabinets outside of telecom rooms shall be bonded to the nearest electrical ground with a BC.

T. LABELING: All labeling systems for telecommunications grounding infrastructure shall be in compliance with the ANSI/TIA -606(A) standard. At a minimum, the following elements shall be labeled in the telecommunications grounding system:

1. All TMGB or TGB, with an unique identifier located in the wall near the unit, not on the ground bar.
2. All TBBs in the project with a unique identifier at each termination point of each TBB. The label in one side of the cable shall indicate the termination location of the other side of the cable.
3. BC for rows of racks with a unique identifier at both ends of the cable
4. BC for surge protectors with a unique identifier at both ends of the cable

U. TESTING: Each installed cable shall be tested for compliance with the cabling performance test procedures defined in ANSI/TIA/EIA-568-B.1.

1. The field testing device shall be Level 2e.
2. The field testing device shall be in good working order and calibrated according to manufacturer’s recommendations.
3. A printout of the field test results for each cable shall be provided to the City Project Manager. Electronic versions of the results may be submitted if these records are in a format acceptable to the City Project Manager.

3.2 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. See specification section 270010 for these requirements.
SECTION 270528
RACEWAYS FOR TECHNOLOGY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
B. Section 260533 - Raceway Systems, apply to work of this Section. Specifications described herein take precedence over Section 260533.
C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 270010 Technology General Provisions
   2. 270526 Grounding and Bonding for Telecommunications Systems

1.2 DESCRIPTION
A. General: Furnish and install complete with all accessories a TIA 569 Pathways and Spaces infrastructure for supporting of Structured Cabling System (SCS) and housing of technology equipment. The goal of the project is to provide a reliable architecture of the building that shall serve as a support for transport of data, voice telephony, security and audio/visual cabling throughout the building from designated demarcation points to places located at various wall, floor, ceiling, column, room and other locations as indicated on the contract drawings and described herein. The cabling that shall be supported includes, but is not limited to:
   1. Copper - UTP 4PR CAT plenum or Non-plenum cable, Multipair CAT plenum and Non-plenum, Multipair telephone general purpose plenum and Non-plenum, RJ45 Patch Panel
   4. Other: Hybrid Cables, Composite cables, Floor Racks and cabinets, Wall mounted racks and cabinets.
   5. The equipment that shall be housed includes, but are not limited to:
      a. Voice Telephony - PBX
      b. Data - Hub, Switch, Router, Modem, Repeater, Transceiver, DSU/CSU.
      c. Other: Multiplexer, Multipurpose switch, UPS
      d. Security head end equipment
      e. Audio/visual system
B. General: For pathways the system shall utilize a combination of conduit, cable tray and supports for vertical and horizontal cabling support. Pathways shall be provided and located as shown and in the quantities indicated on the drawings. Pathways shall terminate in rooms or closets using approved fasteners and termination hardware and bushings and shall be reamed to eliminate sharp edges. All Pathways shall be identified at all locations.
C. All installers should anticipate that all products and installation procedures shall comply with the ANSI/TIA-569-A (CSA T530) requirements at a minimum.
   General: Installation of the raceways for communications shall be a complete system including all supports and hangers as required per contract documents and manufacturer’s installation guidelines.
D. Support: All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters’ Laboratories. Wire shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels. Do not install any devices supported by ceiling tiles.
E. Installation: The Installer shall layout and provide his work in advance of the laying of floors or walls, and shall provide all sleeves that may be required for openings through floors, walls, etc. Where plans call for conduit to be run exposed, provide all inserts and clamps for the supporting of conduit.
F. Pull Strings: Provide pull strings in all raceways. Pull strings shall be nylon and shall be impervious to moisture. Pull strings installed in one (1) inch and smaller conduits shall have a tensile strength of not less than 30 lbs. Pull strings installed in conduits larger than one (1) inch shall have a tensile strength not less than 200 lbs.

1.3 INSTALLER QUALIFICATIONS
A. General: The installer selected for the Project must be BICSI certified installer and certified by the manufacturer for the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning the Project.
B. General: The Installer directly responsible for this work shall be a "Pathways and Spaces for Structured Cabling System Installer (PS-SCS)" who is, and who has been, regularly engaged in the providing and installation of commercial and industrial pathways and spaces for telecommunications wiring systems of this type and size for at least the immediate past five years. Any sub-Installer who will assist the PS-SCS installer in performance of this work, shall have the same training and certification as the PS-SCS installer.

C. Certification: The installer's Project Manager shall possess a current and in good standing BICSI Registered Communications Distribution Designer (RCDD) certificate. All shop drawings submitted by the installer shall bear the RCDD's seal.

D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and have personnel who are adequately trained in the use of such tools and equipment.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS
A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

1.5 SHOP DRAWINGS AND SUBMITTALS
A. See additional requirements for shop drawings and submittals in specification section 270010.
B. General: The PS-SCS installer shall provide no later than 30 days after contract award the following information:
   1. Proof of Installer's qualifications per paragraph 1.03.
   2. Cut sheets of all products to be used for the project, highlighting in particular the precise product to be used in each case, when multiple devices are indicated in the cut sheet. At a minimum the following devices shall be submitted with this specification section:
      a. Supporting devices (j-hooks) if allowed in the project. See part 3 of this specification.
      b. Cable tray system with accessories
      c. Runway cable tray system with accessories.
      d. Plywood
      e. Trough wall/floor firestop system
      f. Innerduct
      g. Detectable tape
      h. Communications vaults
      i. Conduit waterfalls
      j. Fire stop system (for small penetrations)
   3. Drawings indicating precise location and type of all support for cable tray or ladder tray systems in all areas where they will be used.

1.6 WORK EXTERNAL TO THE BUILDING
A. General: Any work external to the confines of this building as shown on the drawings shall be governed by provisions of this specification.

PART 2 - PRODUCTS

2.1 CONDUIT
A. All conduits as indicated in Section 26

2.2 OUTLET BOXES
A. Outlet boxes shall be metallic 4"x4", having “Single Gang” faceplate adapters and ¾” or 1” inch EMT conduit extended above ceiling height and equipped with fiberglass bushings to protect cables. The use of surface raceway and surface mounted outlets is not acceptable unless specifically authorized by the City project manager. All materials shall be supplied and installed by the contractor.

2.3 HIGH DENSITY POLYETHYLENE (HDPE) PIPE
A. HDPE pipe shall be used for all directional boring applications, or it can also be used for open trench applications. HDPE pipe shall comply with the following manufacturing standards:
   1. ASTM D 3035 Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter.
   2. ASTM D 2239 Polyethylene (PE) Plastic Pipe (SIDR) Based on Controlled Inside Diameter.
   3. ASTM F 2160 Solid wall High Density Polyethylene (HDPE) Conduit based on Controlled Outside Diameter (O.D.)
4. NEMA TC-7 Smooth Wall Coilable Polyethylene Electrical Plastic Conduit.

B. HDPE pipe shall be manufactured from a suitable thermoplastic polymer conforming to the minimum standard of PE334420E/C as defined in ASTM D3350. The resin properties shall meet or exceed the values listed below for HDPE pipe:

<table>
<thead>
<tr>
<th>ASTM Test</th>
<th>Description</th>
<th>Values HDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-1505</td>
<td>Density g/CM 3</td>
<td>0.941 - 0.955</td>
</tr>
<tr>
<td>D-1238</td>
<td>Melt Index, g/10 min Condition E</td>
<td>0.05 - 0.50</td>
</tr>
<tr>
<td>D- 638</td>
<td>Tensile strength at yield (psi)</td>
<td>3000 min.</td>
</tr>
<tr>
<td>D-1693</td>
<td>Environmental Stress Crack Resistance Condition B,F 20</td>
<td>96 min.</td>
</tr>
<tr>
<td>D-790</td>
<td>Flexural Modulus, MPa (PSI)</td>
<td>80,000 min.</td>
</tr>
<tr>
<td>D-746</td>
<td>Brittleness Temperature</td>
<td>-75°C</td>
</tr>
</tbody>
</table>

C. Design selection: The HDPE pipe used in this project shall be Rib/Smooth – Ribbed Interior and Smooth Exterior wall. Pipe shall be available in multiple colors, non-lubricated and shall include a factory installed 1,800 lbs polyester pull tape. HDPE pipe walls shall be in compliance with SDR 7 - ASTM D3035 specifications and shall have footage markings.

D. Approved manufacturer: Carlon Industries or approved equal.

2.4 WIREWAYS

A. General: Wireway shall be sized as shown on drawings, NEMA 1, lay-in type. Wireway sides and bottom shall contain no knock-outs unless shown otherwise on the drawings. The Installer shall punch holes required. The cover shall be hinge type with quarter turn fasteners to hold cover shut. Covers and bodies shall be 16 gauge steel. Wireway shall be as manufactured by Hoffman Engineering Company, Square “D” or Steel City.

2.5 SUPPORTING DEVICES

A. Hangers: Hangers shall be made of durable materials suitable for the application involved. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by galvanizing, or approved suitable preservative methods.

B. Non-continuous cable supports (j-hooks) shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed.

C. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

D. Non-continuous cable supports sized 1 5/16” and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

E. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.

F. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.

G. Anchoring: Insert anchors shall be installed on concrete or brick construction, with hex head machine screws. Recessed head screws shall be used in wood construction. An electric or hand drill shall be used for drilling holes for all inserts in concrete or similar construction. Installed inserts, brick, shall be near center of brick, not near edge or in joint. Drilled and tapped, and round head machine screws shall be used where steel members occur. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust-resisting metal, or accepted substitution. Gunpowder or lead set anchors are not permitted.

H. Accessories: Non-continuous support systems shall be provided with the adequate mounting accessories depending on the location where the support will be installed, like beam clips, flange clips, C and Z purlin clips.

I. Accepted manufactures; Erico or Panduit.

2.6 CABLE TRAY AND FITTINGS (BASKET TYPE)

A. General Description: Basket type cable tray system is to be constructed of welded steel wire mesh with continuous safety edge wire lip. Provide mesh system permitting for continuous ventilation of cables and maximum heat dissipation.

B. Materials: Carbon Steel: Cable management system to be manufactured from high strength minimum 6 gauge steel wires. Wire to be welded and bent prior to surface treatment.

C. Finishes: Electro-plated zinc Galvanizing: Electrodeposited zinc coating applied to an average thickness of 0.7 mils to 0.8 mils.

D. Hot Dip Galvanizing: Hot dip galvanizing in molten zinc bath providing an average coating thickness of 2.4 mils to 3.2 mils.

E. Equipment Gray: Powder painted surface treatment using ASA 61 Gray Polyester coating or as shown on the drawings.
F. Cable tray dimensions: as shown on the drawings.
G. Fittings: Cable tray fittings to be field manufactured from straight sections through use of hardware and instructions recommended by Manufacturer. Provide drop-off, 90° kits and tees as required using manufacturer fabricated products and installation guidelines.
H. Installation: Cable tray system to be installed using splice connectors, and support components as recommended by the Manufacturer.
I. Loading Cable tray system to be installed and supported per NEMA VE-2 and Manufacturer's suggested span load criteria.
J. The cable tray system shall be UL listed and classified as a continuous bonded tray system providing a continuous grounding path. Cable tray system is required to be tested for grounding adequacy per NFPA 70B, Chapter 18 with a maximum allowable resistance of 1 ohm.
K. Approved Manufacturers: Wiremold, Cablofil, Snake Tray, B-line or Chatsworth.

2.7 CABLE TRAY AND FITTINGS (LADDER TRAY TYPE)

A. CABLE TRAY SECTIONS AND COMPONENTS

1. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

2. Materials and Finish: Material and finish specifications for each cable tray type are as follows:

   a. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray. All hot-dip galvanized after fabrication steel cable trays must be returned to point of manufacture after coating for inspection and removal of all icicles and excess zinc. Failure to do so can cause damage to cables and/or injury to installers.

B. TYPE OF TRAY SYSTEM

1. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 12 inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200 pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.

2. Tray Sizes shall have 4 inch minimum usable load depth, or as noted on the drawing.

3. Straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard 10 foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.

4. Tray widths shall be as shown on drawings.

5. All fittings must have a minimum radius as the width of the tray.

6. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.

   a. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1. If aluminum cable tray is to be used outdoors then hardware shall be Type 316 stainless.

7. Splice plates shall be furnished with straight sections and fittings.

8. Cable Tray Supports: Shall be placed so that the support spans do not exceed maximum span indicated on drawings. Supports shall be constructed from 12 gauge steel formed shape channel members 1-5/8 inch by 1-5/8 inch with necessary hardware such as Trapeze Support Kits. Cable trays installed adjacent to walls shall be supported on wall mounted brackets. All types of supports shall be factory made supports supplied by the same manufacturer of the cable tray system as recommended for the type of cable tray selected.

9. Trapeze hanger supports shall be supported by 3/8 inch (minimum) diameter rods.

10. Barrier Strips: Shall be placed as specified on drawings and be fastened into the tray with self-drilling screws.

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11. Accessories - special accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.

C. LOADING CAPACITIES
   1. Cable tray shall be capable of carrying a uniformly distributed load of 109 lbs./ft. on a 12 foot support span with a safety factor of 1.5 when supported as a simple span and tested per NEMA VE1 Section 5.2. In addition to the uniformly distributed load the cable tray shall support a 200 lb. concentrated load at mid-point of span and centroid of tray. Load and safety factors specified are applicable to both side rails and rung capacities.

D. Approved Manufacturers: B-line, Chatsworth or approved equal.

2.8 RUNWAY CABLE TRAY AND FITTINGS
   A. Materials: ASIM A36 steel bar.
   C. Finish color: to match equipment cabinet finish color. See specification section 271000.
   D. Cable management tray width: as shown on the drawings.
   E. Fittings: Cable management fittings and hardware recommended by Manufacturer. Provide drop-off, 90° and tees as required for the equipment served and support of the cable. Provide at least one large radius drop off for each rack/cabinet in the project.
   F. Installation: Cable management system to be installed using support components as recommended by the Manufacturer.
   G. Loading: Cable management system to be installed and supported per Manufacturer’s suggested span load criteria.
   H. Approved Manufacturers: B-line, GS Metals, and Chatsworth.

2.9 PLYWOOD BOARDS IN TELECOMMUNICATION ROOMS
   A. Plywood Backboard: Backboards shall be installed in each TR and the MTR on walls to a height of 8’ AFF or as shown on the drawings. Rooms shall have walls covered as shown on the drawings. Plywood shall be ¾” AC Grade with the best side out. All imperfections and voids shall be filled, sealed and sanded prior to being primed and painted with two (2) coats of UL Classified, fire retardant intumescent paint on the front, back and all four sides of the plywood. Fire retardant coating shall be tested to UL723, “Test for surface burning characteristics of building materials.” Color to be grey, white or blue. Coordinate color selection with the Owner/Architect. Backboards shall be clearly labeled with the name of the Backboard Manufacturer, UL Classification of the Fire Retardant Coating, NFPA 255 Coating Flame Spread Index Class and the APA Grade of the plywood.
   B. Design Selection: Series Pathways & Spaces, Inc. ReadySpec Series or equal, field fabricated backboards to all of the specifications listed above for “plywood backboards”. All voids shall be filled and sanded smooth, prior to applying 1 coat of primer, and two coats of UL Classified Fire Retardant paint. The installer shall provide proof that ¾” AC Grade Plywood and UL Classified paint was used in making the backboards. Furthermore, the installer shall provide verification that all backboards were primed, and painted on all sides (front, back and all sides) with two coats of the required paint. Proof of compliance shall be submitted upon project completion as part of the closeout documentation.
   C. Terminal Board Conduits: Conduits at Terminal board locations shall be neatly racked on a Kindorf Type rack secured to wall above and below terminal boards.

2.10 THROUGH WALL/FLOOR FITTING FIRE STOP SYSTEM
   A. General. These devices covered under this specification are firestop devices for use in through-penetration firestop systems, which are used to maintain the fire rating of the wall or floor, as well as to route and protect power and/or communications cable distribution for commercial, educational, healthcare, government, institutional, industrial and utility needs.
   B. Classification and use: The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of 3.3 cfm. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4 1/2" (114mm) thick reinforced lightweight or normal weight (100-150 pcf) (1600-2400 kg/m3). The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.
   C. Materials:
      1. Box: The fire stop device box shall be constructed of 16 gage G90 steel.
      2. Intumescent block: The fire stop device intumescent block shall be constructed of a graphite base material with expansion starting at 375º F and an unrestrained expansion between 6 to 12 times.
The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.

3. Adjustable doors: the fire stop device shall have doors or other system which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gauge G90 steel with no. 10-32 screws used to adjust opening size.

4. Heat shield: For retrofit applications where an existing in-wall conduit extends out from the wall more than 7/8" [22mm], a UL listed Heat Shield must be used in order to maintain UL Fire Classification. The firestop device is then installed onto the heat shield.

5. Split conduit and wall plate: For retrofit applications where no conduit is installed in the wall to protect existing cables, a split conduit assembly should be used to protect cables. After installing the split conduit within the wall, a wall plate should be installed to cover any irregularly shaped hole cut in the wall. The firestop device is then installed onto the conduit.

D. Sizes: the fire stop device shall be available for two (2) inch and four (4) inch trade size emt conduit.

E. Finish: the fire stop device shall be available in safety yellow or orange powder coat, custom colors and an unpainted galvanized finish.

F. Design selection: Wiremold FlameStopper, STI EZpath or approved equal

2.11 INNERDUCT (REGULAR)

A. Flexible raceway system also referenced in the design documents as regular innerduct or innerduct shall be provided in locations indicated in design drawings. The innerduct type shall be selected according to the environment where it will be installed, use HDPE innerduct only outdoors, use plenum or riser rated innerduct indoors. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.

B. For plenum rated applications, the specifications of the innerduct shall be:

1. Material: White or orange Kynar PVDF Resin, a fluoropolymer compound.
2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
3. Marking: Footage shall be sequentially marked.
5. Pull line: built in 900 lb rated tape.
6. Size: Shall be available in ¾” through 2" diameters.

C. For riser rated applications, the specifications of the innerduct shall be:

1. Material: Orange polyvinyl chloride (PVC).
2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
3. Marking: Footage shall be sequentially marked.
5. Pull line: built in 900 lb rated tape.
6. Size: Shall be available in ¾” through 2" diameters.

D. For outdoor applications, the specifications of the innerduct shall be:

2. Listing: None.
3. Marking: Footage shall be sequentially marked.
5. Pull line: built in 1,800 lb rated tape.
6. Size: Shall be available in ¾” through 2” diameters.

E. All inner ducts shall be provided with couplings and accessories suitable for the environment where they will be installed.

F. Design selection: products by Carlon or approved equal.

2.12 INNERDUCT (FABRIC TYPE)

A. When indicated in the design drawings, high capacity innerduct made of fabric shall be used inside telecommunication raceways to facilitate the pulling of telecommunication wires in those raceways. The fabric type Innerduct (also referenced as textile innerduct) shall have the following specifications:

1. Material: White Polyester and Nylon resin polymer
2. Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape.
3. Indoor Textile Innerduct (Riser-listed): Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.
4. Plenum-Listed Textile Innerduct: Micro (33mm), 2-inch and 3-inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.
B. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.
C. Design selection: Products manufacturer by The Maxcell Group or approved equal. Approved equal shall be only of the fabric type innerduct.

2.13 CONDUIT WATERFALLS
A. All 4” EMT terminations with communication cable entering/exiting the conduit from a cable tray (or tubular runway) system and the vertical separation between raceways is larger than 7” shall be fitted with a device to control the bend radius of the communication cable to a minimum of a 4” radius. The device to control the bend radius shall be called a conduit waterfall and must comply with all National Electrical Code requirements and TIA Standards. In addition, the product must be RoHS compliant to meet environmental requirements, be UL 94V-0 approved to reduce the spread of flame, and be approved by UL for use in air handling spaces. The device to provide bend radius control must support a static load of 40 lbs. (177.9 N) and have a fastening device that allows for incremental adjustments to conform to variances in conduit diameters.
B. Device quantities are not indicated in the drawings but the PS-SCS shall use all 4” conduits and sleeves indicated in the drawings to estimate the quantities of waterfalls to be used in the project.
C. Basis of design: Panduit CWF 400 or approved equal.

2.14 FIRE STOP SYSTEMS (FOR SMALL PENETRATIONS)
A. General: Fire stop system shall be selected by the PS-SCS installer as to comply with the following requirements:
   1. Selected system shall be UL listed for the condition on which it will be installed. These conditions include: wall/slab type (masonry, drywall, etc), hour rating, and accessibility type.
B. Acceptable systems: caulk based products or firestop grommets by STI or equal.

2.15 EXPANSION FITTINGS
A. Installation: Provide expansion fittings in each conduit run wherever it crosses an expansion joint. Install the fitting on one side of the joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.
B. Location: Provide expansion fittings in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.
C. Length: Provide expansion fittings in straight conduit runs above ground which are more than one hundred (100) feet long.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES
A. See additional requirements indicated in part 3 of specification section 270010.

3.2 INDOOR CONDUITS BELOW GRADE AND ABOVE GRADE
A. BEND RADIUS. Conduits shall utilize long radius sweeps at all 90 degree transitions. The inside radius of a bend in conduit shall be at least six (6) times the internal diameter. When the conduit size is greater than two (2) inches, the inside radius shall be at least ten (10) times the internal diameter of the conduit. For fiber optic cable, the inside radius of a bend shall always be at least ten (10) times the internal diameter of the conduit.
B. MAXIMUM DISTANCE BETWEEN JBOXES. For indoor installation no section of conduit shall be longer than one hundred (100) ft or contain more than two (2) 90 degree bends between pull points or pull boxes are required. For outdoor installation no section of conduit shall be longer than six hundred (600) ft or contain more than two 90 degree bends between pull points or pull boxes are required.
C. LABELING. All indoor conduits 2” or larger shall be labeled at both ends when these conduit runs are continuous between two rooms and going through multiple walls or slabs. Labeling materials shall be as indicated in specification section 270010. Conduit sleeves 2” or larger penetrating just one wall is not required to be labeled.
D. PULL STRINGS; All conduits for technology systems shall be installed with pull strings.

3.3 CUTTING AND PATCHING
A. Core Drilling: The installer shall be responsible for all core drilling as required for work under this section, but in no case shall the installer cut into or weld onto any structural element of the project without the
written approval of the A&E. Any post tension slabs or slabs with embedded electrical raceways shall be X-rayed prior to coring by the installer.

B. Cutting and Patching: All cutting, rough patching and finish patching shall be provided as specified in the contract documents. All cutting and patching shall be performed in a neat and workmanlike manner.

C. Openings and Sleeves: Locate all openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.

D. Roof Penetration: All roof penetrations for raceways part of technology systems shall be approved by A&E prior to executing this work. All roof penetrations shall be as accepted by the roof manufacturer.

3.4 IDENTIFICATION OF BOXES

A. Tags: During installation of pull strings all pull strings shall be marked with waterproof vinyl tags indicating where the opposite end may be found.

3.5 BLANK PLATES

A. Plates: Unless otherwise noted all unused outlet boxes shall receive blank plates matching the finish of plates for electrical devices in the same room.

3.6 RACEWAY INSTALLATION

A. SUPPORT. All raceways shall be run in a neat and workmanlike manner and shall be properly supported and in accordance with the latest edition of the NEC code and BICSI guidelines. Supporting conduit and boxes with wire is not acceptable. Exposed raceways where allowed shall be supported with clamp fasteners with toggle bolt on hollow walls, and with no lead expansion shields on masonry. All conduits shall be securely fastened in place with at least one support per eight foot section. Support within one foot of changes in direction. All required hangers, supports and fastenings shall be provided at each elbow and at no more than one foot from the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits shall not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

B. HANGER INSTALLATION. Where two (2) or more conduits one (1) inch or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These conduits shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.

C. NON-CONTINUOUS CABLE SUPPORTS INSTALLATION. Install non-continuous cable supports (j-hooks) only as recommended by manufacturer not exceeding the load ratings of the devices. Install non-continuous cable supports in spans no longer than 4’. Whenever there are changes in elevation additional supports shall be required to avoid having stress on cable or sharp bends.

D. FIRE STOPPING: For 4” sleeves, the PS-SCS installer shall provide through wall/floor fittings firestop system and for other smaller sleeves or wall penetrations through fire rated partitions the PS-SCS installer can use the same type of firestop system or a fire stop system for small penetrations in compliance with products described in part 2 of this specification.

E. PENETRATIONS IN FIRE RATED PARTITIONS. Installation of electrical boxes or equipment back boxes in fire rated walls and smoke barriers shall follow the following requirements:

1. Electrical boxes and or technology system backboxes can be installed in 1 or 2 hour rated walls as long as all requirements indicated in the proper Building Code, National Electrical Code and nationally recognized testing laboratories are met for this type of installation.

2. As a summary, some of the requirements indicated by the codes listed above are:
   a. Boxes shall be metallic or listed for that purpose
   b. The area of the boxes shall not exceed 16 square inches, provided the aggregate are of the openings through the membrane does not exceed 100 square inches in any 100 square feet of wall area.
   c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch.
   d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used.

3. Electrical boxes or technology systems backboxes shall not be installed in a 3 or 4 hour fire rated wall.
3.8 RUNWAY CABLE TRAY SYSTEM INSTALLATION

A. General. Runway cable tray system shall be installed following manufacturer’s recommendations for installation.

B. Support locations: supports shall be provided as recommended by the manufacturer, but as a minimum supports shall be located as follows:

1. Before each 90 deg turn.
2. No continuous section shall have more than 3ft of span without a support.
3. At each 2-post rack or 4-post rack.
4. At each change in elevation
   C. Support type. When runway cable tray is to be installed against the wall, the only support type to be used
      is a wall bracket supporting from the bottom of the tray. For sections of runway cable tray to be installed
      over racks, the preferred support system is to the racks themselves. Trapeze style support brackets shall
      only be used when no other method of support is possible. Center hung support systems shall never be
      used.
   D. Vertical runways. Runway cable tray system shall be installed continuously vertically in all
      telecommunications rooms in the project from sleeves coming from the ground (or floor below) to the
      sleeves going to the floor above, whether or not indicated in the drawings. The runway installed shall have
      the same width as the total width of the sleeves coming into the telecommunications room, although
      multiple sections installed together are acceptable. If the sleeves from the floor below to the floor above
      don’t line up in a straight line, two vertical sections are accepted, one to the horizontal runway cable tray
      and one from the horizontal runway cable tray to the sleeves above. Runway cable trays installed
      vertically shall have supports to the floor, wall and slab above.
   E. Cable dropout. At each rack or cabinet that has runway cable tray system running on top of it, a cable
      dropout shall be installed to protect the bend radii of the cable. This dropout accessory shall have a bend
      radius of no less than 4".
   F. Bonding. Any two continuous sections of runway cable tray system shall be bonded together with a #1
      bonding jumper (600A) 15” long. All bonding jumpers shall be made of steel with yellow, zinc-dichromate
      finish. All fasteners shall be made of steel with zinc-plated finish
   G. Protective end caps. All end sections of runway cable tray sections shall be protected with plastic
      protective end caps.

3.9 INSTALLATION OF INNERDUCT
   A. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during
      construction.
   B. When inner duct is laid on a cable tray, it shall be strapped to cable tray with nylon ty-wraps at periodic
      intervals of no less than 4 ft.
   C. When multiple innerduct are run in a single conduit, and innerduct are of the same size, they shall be
      different colors for identification or have different color electrical taped wrapped on the ends to identify
      them at the end of each conduit.

3.10 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION
   A. See specification section 270010 for as built documents and close out information these requirements.

END OF SECTION
PART 1-GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section.

B. Reference Standards:
   1. ANSI/TIA/EIA-568-A
   2. ANSI/TIA/EIA-569-A
   3. ANSI/TIA/EIA-606
   4. J-STD-607-A
   5. NEMA
   6. UL 1863 Communication Circuit Accessories
   7. UL-50 & UL-514
   8. NEC

C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.

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1.2 DESCRIPTION

A. General: This specification covers a box system used for bringing power and low-voltage devices to one location in an on grade or above grade concrete floor. The system shall consist of an in-the-floor box, mounting brackets, dividers and power devices, trim ring, modular inserts and device faceplates for a complete installation in accordance with the drawings. The system shall provide all plates and bezels to mount Structured Cabling System devices. The boxes shall be of such form and dimensions as to be adapted to the specific use and location, type of device or fixtures to be used, and number and size of conductors and cables, size and number of conduits connecting thereto.

B. General: Provide floor outlet boxes as shown on the plans. Installation shall be in accordance with the National Electrical Code, and shall be complete with service fittings as indicated. Equipment shall be listed by Underwriters' Laboratories, Inc.

C. Telecommunications Connections: Category 6 modular jack inserts are to be used in conjunction with telecommunication mounting housings (i.e., faceplate, mounting bezel or communication bracket). Category 6 modular jack inserts are designed to meet TIA/EIA connecting hardware requirements as shown on the drawings and as specified in specification section 271000.

1.3 QUALITY ASSURANCE

A. Qualifications: Manufacturers shall be regularly engaged in the manufacture of box systems and fittings of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years in the USA.

1.4 SUBMITTALS

A. Submittals: Submit manufacture’s data showing full range of specified products. Indicate selected submittal items, including accessories, finishes and options.

B. Shop Drawings: Submit drawings for approval showing the complete layout of products that make up the complete floor box and faceplate system. Electrical and communication device locations on the drawings are diagrammatic. Location and type of outlets shall be coordinated with appropriate trades involved. Final outlet locations shall be done with the approval of the architect.

C. Samples: Submit samples of boxes complete with dividers, mounting brackets, trim rings, face plates, labeling, inserts, and accessories.
D. Substitutions: Systems of other manufacturers may be considered. Written request for approval must be submitted to the Construction Manager at least ten days prior to bid date. Each request shall include the name of the materials, product data, samples and a complete description of the proposed substitute.

PART 2-PRODUCTS

2.1 FLOOR OUTLET BOXES

A. General. Provide cast iron boxes for slab on grade applications, and steel boxes for slab above grade applications. Outlets in slab on grade shall conform to Federal Specifications No. WC-526b, Type 1, with threaded conduit hubs

B. Construction: All assemblies shall be designed and installed to maintain grounding continuity, fireproofing and watertight integrity. Connections to boxes in slabs on grade shall be made tight or sealed to prevent entrance of moisture.

C. Accessories: Box trim, service fittings and flanges, receptacle brackets, communications brackets, and other accessories shall be as required to provide a complete installation.

D. Special Consideration: Flush caps removed to provide service fittings shall be turned over to the Owner.

E. This floor box shall have been examined and tested by Underwriters Laboratories Inc. to Standard UL514A and/or UL514C and Canadian Standard C22.2, No. 18-92 and bear the U.S. and Canadian UL Listing Mark. This floor box shall also conform to the standards set in the National Electrical Code, Section 300-21. This floor box shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.

F. Basis of design. The in-floor box described shall be Walker RFB4 manufactured by The Wiremold Company. Floor boxes of other manufacturers may be considered, if equal in functionality and quality, by written approval of the specifying engineer and shall meet all the performance standards specified herein. Refer to “T” drawings for more details on floor boxes selection and configurations. Refer to Electrical Drawings for power distribution system.

PART 3-EXECUTION

3.1 FLOOR OUTLET BOXES

A. Adjustment: Where floor or fill depth is 3 inches or more, adjustable boxes with maximum vertical and angular adjustment for after concrete pour shall be used. After pour is complete, boxes shall be set and readjusted to provide a smooth surface conforming to the elevation and slope of the surrounding finished floor. The box shall contain four locations to accommodate leveling for pre-concrete pour adjustment and shall provide four leveling screws for the pre-pour adjustment. Cover plate will be flush mounted to final finish height and material.

B. Installation procedures and practices shall be in strict accordance with applicable codes and standards. Prior to and during installation, refer to system layout drawing containing elements of the systems. Installer shall comply with manufacturer’s printed installation instructions.

C. Electrical Security: The boxes shall be electrically continuous and connected to electrical outlets, boxes, and cabinets, in accordance with manufacturer’s installation instructions.

3.3 QUALITY CONTROL

A. The Communications Cabling Contractor’s quality control manager shall be a certified by the Building Industry Consulting Service International as a Registered Communications Distribution Designer (RCDD). The quality control manager shall be onsite during performance of the work and he or she shall have installation responsibility for communications cabling.

B. Completeness: Work shall include installing box, device mounting bracket, devices, device plates, labels and blank plates for a complete in-the-floor system as indicated on the drawings.

C. All equipment shall be warranted for one year from the date of final acceptance.
SECTION 283111
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

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 GENERAL
A. Existing fire alarm system is manufactured by Simplex. Fire Alarm Control Panel, devices, and wiring shall be modified as required to conform to current codes and NFPA 72 as an addressable system inclusive of voice notification. Contractor shall visit the site prior to bid and confirm the existing system is adequate to meet these requirements.

1.3 SUMMARY
A. Section Includes:
   1. Fire-alarm control unit.
   3. System smoke detectors.
   7. Addressable interface device.
   8. Digital alarm communicator transmitter.

1.4 DEFINITIONS
A. LED: Light-emitting diode.

1.5 SYSTEM DESCRIPTION
A. Non-coded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire alarm and voice notification service.
B. Non-coded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm and voice notification service.

1.6 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
   B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
      2. Include voltage drop calculations for notification appliance circuits.
      3. Include battery-size calculations.
      4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
      5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
      6. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
   C. General Submittal Requirements:
      1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
      2. Shop Drawings shall be prepared by persons with the following qualifications:
         a. Trained and certified by manufacturer in fire-alarm system design.
         b. NICET-certified fire-alarm technician.
         c. Licensed or certified by authorities having jurisdiction.
1.7 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.
   B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
      1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
      3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   C. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
   3. Record copy of site-specific software.
   4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
      a. Frequency of testing of installed components.
      b. Frequency of inspection of installed components.
      c. Requirements and recommendations related to results of maintenance.
      d. Manufacturer's user training manuals.
   5. Manufacturer's required maintenance related to system warranty requirements.
   6. Abbreviated operating instructions for mounting at fire-alarm control unit.
B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.9 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no less than 1 unit.
   2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no less than 1 unit.
   3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no less than 1 unit of each type.
   4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no less than 1 unit of each type.
   5. Keys and Tools: One extra set for locked and tamper proofed components.
   6. Audible and Visual Notification Appliances: One of each type installed.
   7. Fuses: Two of each type installed in the system.

1.10 QUALITY ASSURANCE
A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
B. Installer Qualifications: Installation shall be by personnel certified by NICET, as fire-alarm technician.
C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
E. NFPA Certification: Obtain certification as requested by Town of Flower Mound.
1.11 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it “NOT IN SERVICE” until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment “NOT IN SERVICE” until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring if not re-used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. SimplexGrinnell LP; a Tyco International company.
   2. Faraday; Siemens Building Technologies, Inc.
   4. Fire Control Instruments, Inc.; a Honeywell company.
   5. Fire Lite Alarms; a Honeywell company.
   6. Gamewell; a Honeywell company.
   7. NOTIFIER; a Honeywell company.
   9. Silent Knight; a Honeywell company.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:
   2. Heat detectors.
   3. Smoke detectors.
   4. Duct smoke detectors.
   5. Automatic sprinkler system water flow.

B. Fire-alarm signal shall initiate the following actions:
   1. Continuously operate alarm notification appliances.
   2. Identify alarm at fire-alarm control unit and remote annunciators.
   3. Transmit an alarm signal to the remote alarm receiving station.
   4. Unlock electric door locks in designated egress paths.
   5. Release fire and smoke doors held open by magnetic door holders.
   6. Activate voice/alarm communication system.
   7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
   8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
   9. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch.
   2. Low-air-pressure switch of a dry-pipe sprinkler system.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   3. Loss of primary power at fire-alarm control unit.
   4. Ground or a single break in fire-alarm control unit internal circuits.
   5. Abnormal ac voltage at fire-alarm control unit.
   7. Failure of battery charging.
   8. Abnormal position of any switch at fire-alarm control unit or annunciator.
   9. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire Alarm Control Unit:
   1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.
   a. Smoke sensors shall additionally communicate sensitivity setting.
   b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.


B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   1. Annunciator and Display: Liquid-crystal type.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Circuits: As required by the Town of Flower Mound.
   1. As required by Town of Flower Mound Code/Ordinance.

D. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

E. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

F. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, and trouble signals shall be powered by 24-V dc source.
   1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

G. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

H. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
   1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
   2. Station Reset: Key- or wrench-operated switch.
   3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
   4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Detectors shall be four-wire type.
   3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
   4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
   7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.6 HEAT DETECTORS
A. General Requirements for Heat Detectors: Comply with UL 521.
B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES
A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

2.8 MAGNETIC DOOR HOLDERS
A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
   1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
   2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
   3. Rating: 24-V ac or dc.
   4. Rating: 120-V ac.
B. Material and Finish: Match door hardware.

2.9 REMOTE ANNUNCIATOR
A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Flush cabinet, NEMA 250, Type 1.
B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE
A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

2.11 ALARM COMMUNICATOR TRANSMITTER
A. Alarm communicator transmitter shall be either digital ore wireless acceptable to the Town of Flower Mound and the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
C. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   5. Communications failure with the central station or fire-alarm control unit.
D. Digital data transmission shall include the following:
   1. Address of the alarm-initiating device.
   2. Zone of the supervisory signal.
   3. Zone of the trouble-initiating device.
   4. Loss of ac supply or loss of power.
   5. Low battery.
   6. Abnormal test signal.
PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION
A. Comply with NFPA 72 for installation of fire-alarm equipment.
B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
C. Smoke- or Heat-Detector Spacing:
   3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
   4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
   5. HVAC: Locate detectors not closer than 5 feet (1.5 m) from air-supply diffuser or return-air opening.
   6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.
D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
E. Heat Detectors: Coordinate temperature rating and location with sprinkler rating and location.
F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
G. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
H. Visible Alarm-Indicating Devices: Refer to Drawings.
I. Device Location-Indicating Lights: Locate in public space near the device they monitor.
J. Fire-Alarm Control Unit: Flush mounted with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
K. Remote Annunciator: Flush mounted with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.2 CONNECTIONS
A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Smoke dampers in air ducts of designated air-conditioning duct systems.
   2. Alarm-initiating connection to activate emergency lighting control.
   3. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
   4. Supervisory connections at valve supervisory switches.
   5. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

3.3 IDENTIFICATION
A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING
A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
3.5 FIELD QUALITY CONTROL
A. Field tests shall be witnessed by authorities having jurisdiction.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. 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.
D. Tests and Inspections:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
      b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
   3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
   4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
   5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
E. Re-acceptance Testing: Perform re-acceptance testing to verify the proper operation of added or replaced devices and appliances.
F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.
H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semi-annual periods. Use forms developed for initial tests and inspections.
I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION
SECTION 313116
TERMITE CONTROL

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. Soil treatment with termiticide.

1.3 SUBMITTALS
A. Product Data: For each type of termite control product.
   1. Include the EPA-Registered Label for termiticide products.
B. Qualification Data: For qualified Installer.
C. Product Certificates: For termite control products, from manufacturer.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located.
B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.
C. Source Limitations: Obtain termite control products from single source from single manufacturer.

1.5 PROJECT CONDITIONS
A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.6 WARRANTY
A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT
A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. BASF Corporation, Agricultural Products; Termidor.
      b. Bayer Environmental Science; Premise 75.
      c. FMC Corporation, Agricultural Products Group; Dragnet FT Prevail.
   2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.3 APPLICATION, GENERAL
A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.4 APPLYING SOIL TREATMENT
A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
D. Post warning signs in areas of application.
E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes temporary excavation support and protection systems.

1.3 PERFORMANCE REQUIREMENTS
A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
   1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

1.4 SUBMITTALS
A. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
B. Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements. ---"Qualification Data: For qualified land surveyor and professional engineer.

1.5 PROJECT CONDITIONS
A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.
   1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
   2. The geotechnical report is included referenced elsewhere in the Project Manual.
B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS
A. General: Provide materials that are either new or in serviceable condition.
PART 3 - EXECUTION

3.1 PREPARATION
A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
   1. Shore, support, and protect utilities encountered.
B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 REMOVAL AND REPAIRS
A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
   1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
   2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving."
   3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION
SECTION 316329
DRILLED PIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Dry-installed drilled piers.

B. Work Included

1. Furnish all labor and materials required to construct drilled concrete piers complete including layout, excavation of shafts, excavation of belled bottoms, temporary steel casings, fabrication and installation of reinforcing steel, furnishing and placing concrete, setting anchor bolts and removal of spoil.

C. Related Sections include the following:

1. Division 1 Section "Temporary Facilities and Controls."
2. Division 3 Section "Cast-in-Place Concrete" for concrete materials and steel reinforcement.
3. Division 5 Section "Structural Steel" for anchor rods installed in drilled piers.

1.3 UNIT PRICES

A. Basis of Bids: Base bids on indicated number of drilled piers; design length from top elevation to bottom of shaft, extended through the bell, if applicable; and diameter of shaft and bell.

B. Basis for Payment: Payment for drilled piers will be made on actual net volume of drilled piers in place and approved. Actual length, shaft diameter and, if applicable, bell diameter may vary to coincide with elevations where satisfactory bearing strata are encountered, and with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts and bells.

1. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, and other items for complete drilled-pier installation.
2. See Division 1 Section "Unit Prices" for list of unit prices.

C. Contract price shall be based on base lengths of piers shown on the Drawings. Unit prices shall be as follows:

1. Unit prices per linear foot for piers longer or shorter than base lengths.

D. Unit prices shall include all labor and materials including overhead and fees for drilled concrete piers. Adjustments to the Contract shall be based on total linear feet greater than or less than the sum of the base
lengths of each pier size. Additional penetration in the bearing stratum greater than the specified penetration shall not be included in determination of increases or decreases of pier lengths related to adjustments in the Contract.

1.4 SUBMITTALS

A. Submittals for Information:

1. Pier Drilling Log: Report of drilled concrete pier construction including actual elevations of top and bottom of each pier, elevation of bearing stratum, penetration into bearing stratum, deviations of pier centerline and plumbness, shaft size, bell size, presence of water, use of temporary casing, placement of concrete, and time of start and finish of excavation.

B. Product Data: For each type of product indicated.

C. Design Mixes: For each class of concrete. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Laboratory Test Reports: For evaluation of concrete materials and mix design.

D. Welding certificates.

E. Record drawings at Project closeout according to Division 1 Section "Closeout Procedures."

1.5 QUALITY ASSURANCE

A. Installer: Company specializing in performing the work of this Section with minimum three projects in similar soil and rock conditions, and with similar shaft sizes, depths, and quantities.


C. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.

D. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 to perform material evaluation tests and to design concrete mixes, as documented according to ASTM E 548.

E. Welding Standards: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
1.6  PROJECT CONDITIONS

A.  Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.

1.  Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

B.  Site Information: A geotechnical report has been prepared for this Project and is included elsewhere in the Project Manual for information only.

1.  Information regarding site conditions is provided for the convenience of the Contractor and is not a warranty that the information represents site conditions that may be encountered. The Owner shall not be responsible for interpretations or conclusions drawn from the information provided by the Contractor.

2.  Additional borings or other exploratory work may be conducted by the Contractor at no cost to the Owner.

PART 2 - PRODUCTS

2.1  STEEL REINFORCEMENT

A.  Refer to Division 03 Section "Cast In Place Concrete."

B.  Bar Supports: Furnish spacers to maintain required concrete cover to sides and bottom of excavation.


2.2  CONCRETE MATERIALS

A.  Provide concrete materials in accordance with Division 3 "Cast-in-Place Concrete."

PART 3 - EXECUTION

3.1  PREPARATION

A.  Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2  EXCAVATION

A.  Unclassified Excavation: Excavation is unclassified and includes excavation to bearing elevations regardless of character of materials or obstructions encountered.
1. Obstructions: Unclassified excavation includes removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions.

B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

C. Excavate shafts for drilled piers to indicated diameters and elevations. Remove loose material from bottom of excavation.

1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
2. Remove water from excavated shafts before concreting.
3. Excavate rock sockets of dimensions indicated.

D. Notify and allow Owner's testing and inspecting agency to test and inspect bottom of excavation prior to placing reinforcement and concrete. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.

1. Do not excavate shafts deeper than elevations indicated, unless approved by Architect.
2. Additional authorized excavation will be paid according to Contract provisions for changes in the Work.

E. Excavate shafts for closely spaced drilled piers and those occurring in fragile or sand strata, only after adjacent drilled piers are filled with concrete and allowed to set.

F. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.

1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.

G. Bells: Excavate bells for drilled piers to shape, base thickness, and slope angle indicated. Excavate bottom of bells to level plane and remove loose material before concrete is placed.

H. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

1. Maximum Variation From Vertical: One percent of length.
2. Maximum Variation From Design Top Elevation: Plus 1 inch to minus 3 inches.
3. Maximum Out-of-Position: One twenty-fourth of the shaft diameter or 3 inches, whichever is less.
4. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.

I. Inspection: Each drilled pier must be inspected and tested by Owner's testing and inspecting agency before placing concrete.

1. Provide and maintain facilities with equipment required for testing and inspecting excavations. Cooperate with testing and inspecting personnel to expedite the Work.
2. Notify Architect and testing agency at least six hours before excavations are ready for tests and inspections.

3.3 STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover to reinforcement.

E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner's independent testing and inspecting agency.

1. Concrete shall be placed within the time limit stated on the Drawings.
2. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete and insert joint dowel bars. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.

B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.

1. Where concrete cannot be directed down shaft without striking reinforcing, place concrete with chutes, tremies, or pumps. Use tremies where a drop of more than 25'-0" is required.
2. Vibrate top 60 inches of concrete.

C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.

1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.

D. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

E. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

F. When hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no greater than 95 deg F.

1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit reports during excavation and concrete placement for drilled piers.
B. A drilled-pier report will be prepared by Owner’s testing and inspecting agency for each drilled pier as follows:

1. Actual top and bottom elevations.
2. Description of soil materials.
3. Description, location, and dimensions of obstructions.
4. Final top centerline location and deviations from requirements.
5. Variation of shaft from plumb.
7. Levelness of bottom and adequacy of cleanout.
8. Ground-water conditions and water-infiltration rate, depth, and pumping.
9. Description, diameter, and top and bottom elevations of temporary or permanent casings.
10. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
11. Bell dimensions and variations from original design.
12. Date and time of starting and completing excavation.
13. Inspection report.
15. Concrete placing method, including elevation of consolidation and delays.
16. Locations of construction joints.
17. Remarks, unusual conditions encountered, and deviations from requirements.
18. Concrete testing results.

C. Concrete: Refer to Section 03 30 00 for sampling and testing of concrete for quality control.

1. Strength level of concrete will be considered satisfactory if averages of sets of 3 consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
2. Test results will be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests will contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in drilled pier, design compressive strength at 28 days, concrete-mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
3. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as sole basis for acceptance or rejection.
4. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate concrete strengths or other requirements have not been met.
   a. Continuous coring of drilled piers may be required, at Contractor's expense, when temporary casings have not been withdrawn within specified time limits or where observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.

3.6 DISPOSAL OF MATERIALS

A. Remove surplus excavated material and slurry and legally dispose of it off Owner’s property.

END OF SECTION 316329
PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Concrete pavers set in aggregate or mortar setting beds.
      2. Steel edge restraints.

1.3 SUBMITTALS
   A. Product Data: For materials other than water and aggregates.
   B. Product Data: For the following:
      1. Pavers.
      2. Mortar and grout materials.
      3. Edge restraints.
   C. Samples for Initial Selection: For the following:
      1. Each type of unit paver indicated.
      2. Joint materials involving color selection.
      3. Exposed edge restraints involving color selection.

1.4 QUALITY ASSURANCE
   A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
   B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
      1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
   B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
   C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
   D. Store liquids in tightly closed containers protected from freezing.

1.6 PROJECT CONDITIONS
   A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
   B. Weather Limitations for Mortar and Grout:
      2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.
         a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.
PART 2 - PRODUCTS

2.1 CONCRETE PAVERS
A. Concrete Pavers: Solid precast concrete paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.
1. Acceptable Product: Subject to compliance with specified requirements, provide “Narrow Modular Tile” by Stepstone Inc. 17025 South Main, Gardena, CA. 90248 (800-572-9029).
   a. Substitutions: In accordance with section 012500 “Substitution Procedures”.
2. Thickness: 2-1/2 inches.
3. Face Size and Shape: Rectangular; 3 inches by 18 inches.
4. Finish/Color: As selected.

2.2 CURBS AND EDGE RESTRAINTS
A. Steel Edge Restraints: Manufacturer’s standard painted steel edging 1/4 inch thick by 5 inches high with loops pressed from or welded to face to receive stakes at 36 inches o.c., and steel stakes 15 inches long for each loop.
1. Manufacturer: As recommended by Paver manufacturer.
2. Color: As selected by Architect from manufacturer’s full range.

2.3 MORTAR SETTING-BED MATERIALS
A. Portland Cement: ASTM C 150, Type I or Type II.
B. Sand: ASTM C 144.
C. Latex Additive: Manufacturer’s standard water emulsion, serving as replacement for part or all of water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.

2.4 GROUT MATERIALS
A. Polymer-Modified Tile Grout: ANSI A118.7, sanded.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Custom Building Products.
      b. Laticrete International, Inc.
      c. MAPEI Corporation.
B. Grout Colors: As selected from Manufacturer’s full line.
C. Water: Potable.

2.5 MORTAR AND GROUT MIXES
A. General: Comply with referenced standards and with manufacturers’ written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout if they have reached their initial set before being used.
B. Mortar-Bed Bond Coat: Mix neat cement and latex additive to a creamy consistency.
C. Packaged Grout Mix: Proportion and mix grout ingredients according to grout manufacturer’s written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.
C. Proceed with installation only after unsatisfactory conditions have been corrected[ and waterproofing protection is in place].

3.2 PREPARATION
A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
3.3 INSTALLATION, GENERAL
A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
C. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
   1. For concrete pavers, a block splitter may be used.
D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.
E. Joint Pattern: As scheduled.
F. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
   1. Install edge restraints to comply with manufacturer’s written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
   2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.
   3. Install job-built concrete edge restraints to comply with requirements in Division 03 Section “Cast-in-Place Concrete.”
   4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
H. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.
   1. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.4 MORTAR SETTING-BED APPLICATIONS
A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
   1. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch thickness for bond coat.
B. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
C. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
D. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch thick bond coat to mortar bed or to back of each paver with a flat trowel.
E. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
F. Spaced Joint Widths: Provide 3/8-inch nominal joint width with variations not exceeding plus or minus 1/16 inch.
G. Grouted Joints: Grout paver joints complying with ANSI A108.10.
H. Grout joints as soon as possible after initial set of setting bed.
   1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
   2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
   3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
   4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
I. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.
3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
   1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
   2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION
SECTION 321714

PRECAST CONCRETE SITE ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes: Providing precast concrete wheel stops and splash blocks where shown on the Drawings and as specified.

1.2 QUALITY ASSURANCE
   A. Reference Standards:
      1. ASTM A 615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
      2. ASTM C 94 - Ready-Mixed Concrete.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE WHEEL STOPS
   A. Qualities: Precast concrete wheel stops, with chamfered corners, drainage slots on underside, reinforced, and having 2 pre-drilled pin holes having 2 cast-in anchor pins.
      1. Concrete: Normal weight concrete, minimum 5000 psi 28-day compressive strength.
      2. Reinforcing: ASTM A 615, Grade 40, two continuous No. 3 deformed reinforcement bars.
      3. Size: 8 inch wide, 6 inch tall, 72 inch long.
   B. Anchor Pins: 5/8 in. deformed bar, 2 for each wheel stop, extending a minimum of 6 inches below bottom of wheel stop.

2.2 PRECAST CONCRETE SPLASH BLOCKS
   A. Precast concrete, reinforced with manufacturer's standard mesh or deformed bars.
   B. Concrete: Normal weight, minimum 4000 psi 28 day compressive strength.
   C. Size: As indicated on Drawings.

2.3 FABRICATION
   A. Use rigid molds, constructed to maintain precast units uniform in shape, size and finish. Maintain consistent quality during fabrication.
   B. Embed reinforcing steel, and drill or sleeve for two dowels.
   C. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
   D. Minor patching in plant is acceptable, providing appearance of units is not impaired.

PART 3 - EXECUTION

3.1 PREPARATION
   A. Verify layout of wheel stop locations with pavement marking layout.
   B. Verify that paving and pavement marking is completed and ready for installation of wheel stops.
   C. Thoroughly clean surfaces to receive wheel stops free of dirt, sand, oil, grease or other foreign matter.

3.2 INSTALLATION – WHEEL STOPS
   A. Install a precast wheel stop at each parking space indicated.
   B. Install wheel stops with anchors in accordance with manufacturer's instructions.
   C. Recess head of dowel slightly beneath top surface of wheel stop.
   D. Leave wheel stops securely anchored and in proper alignment.

3.3 INSTALLATION - SPLASH BLOCKS
   A. Place blocks and pads on smooth, even topsoil. Place level and solidly supported.

END OF SECTION
SECTION 323119
DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Decorative metallic-coated steel tubular picket fences.
   2. Swing gates.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples: For each fence material and for each color specified.
   1. Provide Samples 12 inches in length for linear materials.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: Fabricator of products.
B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. UL Standard: Provide gate operators that comply with UL 325.
E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.
   1. Include 10-foot length of fence complying with requirements.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 STEEL AND IRON
A. Plates, Shapes, and Bars: ASTM A 36.
B. Tubing: ASTM A 500, cold formed steel tubing.
C. Uncoated Steel Sheet: Grade 310 cold-rolled steel sheet, ASTM A 1008, Structural Steel, Grade 50.
D. Galvanized-Steel Sheet: ASTM A 653, structural quality, Grade 50, with G90 coating.
E. Castings: Either gray or malleable iron unless otherwise indicated.

2.2 COATING MATERIALS
A. Epoxy Zinc-Rich Primer for Steel: Complying with MPI #20 and compatible with coating specified to be applied over it.
   1. Products: Subject to compliance with requirements, provide one of the following:
   2. Use primer with a VOC content of 400 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
   1. Products: Subject to compliance with requirements, provide one of the following:
   2. Use product with a VOC content of 400 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MISCELLANEOUS MATERIALS
A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.
B. Concrete:
1. Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 03, Section "Cast-in-Place Concrete".
2. Minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size or dry, packaged, normal-weight concrete mix.
4. Mixed with potable water, according to manufacturer's written instructions.

2.4 DECORATIVE METALLIC-COATED STEEL TUBULAR PICKET FENCES

A. Decorative Metallic-Coated Steel Tubular Picket Fences: Comply with ASTM F 2408, for light industrial (commercial) application (class) unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ameristar Fence Products.
   b. Fortress Iron; a division of Woodmark International, LP.
   c. Master Halco.
   d. Merchants Metals; a division of MMI Products, Inc.

B. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc alloy-coated steel sheet.

C. Interior surface of tubes formed from uncoated steel sheet shall be hot-dip zinc coated same as exterior.

D. Posts:
   1. End and Corner Posts: Square tubes 3 by 3 inches formed from 0.108-inch nominal-thickness, metallic-coated steel sheet or formed from 0.105-inch nominal-thickness steel sheet and hot-dip galvanized after fabrication.
   2. Swing Gate Posts: Square steel tubing 3 by 3 inches with 3/16-inch wall thickness, hot-dip galvanized.

E. Post Caps: Formed from steel sheet and hot-dip galvanized after forming.

F. Rails: Square tubes.

G. Pickets: Square tubes.
   1. Terminate tops of pickets at top rail for flush top appearance.
   2. Picket Spacing: 6 inches clear, maximum.

H. Fasteners: Manufacturer's standard concealed fastening system.

I. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified in ASTM F 2408, hot-dip galvanize to comply with ASTM A 123. For hardware items, hot-dip galvanize to comply with ASTM A 153.

J. Finish: Powder coating.

2.5 SWING GATES

A. Gate Configuration: As indicated.

B. Gate Frame Height: As indicated.

C. Gate Opening Width: As indicated.

D. Steel Frames and Bracing: Fabricate members from square steel tubing 2 by 2 inches with 1/8-inch wall thickness, hot-dip galvanize frames after fabrication.

E. Frame Corner Construction: Welded and 5/16-inch diameter, adjustable truss rods for panels 5 feet wide or wider.

F. Additional Rails: Provide as indicated, complying with requirements for fence rails.

G. Infill: Comply with requirements for adjacent fence.

H. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.

I. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking, padlock accessible from both sides of gate.

J. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.
   1. Function: 320 - Gate spring pivot hinge. Adjustable tension.

K. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 1/2-inch-diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

L. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

M. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123 unless otherwise indicated. For hardware items, hot-dip galvanize to comply with ASTM A 153.

N. Metallic-Coated Steel Finish: High-performance coating.
2.6 METALLIC-COATED STEEL FINISHES
A. Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a zinc-phosphate conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
B. Powder Coating: Immediately after cleaning and pre-treating, apply 2-coat finish consisting of zinc-rich epoxy prime coat and TGIC polyester topcoat, with a minimum dry film thickness of 2 mils for topcoat. Comply with coating manufacturer's written instructions to achieve a minimum total dry film thickness of 4 mils.
   1. Comply with surface finish testing requirements in ASTM F 2408 except change corrosion-resistance requirement to 3000 hours without failure.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
   1. Construction layout and field engineering are specified in Division 01 Section “Execution”

3.3 DECORATIVE FENCE INSTALLATION
A. Install fences according to manufacturer's written instructions.
B. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.
C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
      a. Exposed Concrete: Extend 2 inches above grade. Finish and slope top surface to drain water away from post.
   3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
   4. Space posts uniformly at dimensions indicated on the drawings.

3.4 GATE INSTALLATION
A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING
A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
B. Lubricate hardware and other moving parts.

END OF SECTION