Project Manual

General Documents, Divisions 00, 01 - 49
ISSUED FOR BID, PERMIT, & CONSTRUCTION
3-13-2020

Project Scope:

STAFFORD HIGH SCHOOL & MAGNET SCHOOL RENOVATIONS
Stafford, Texas

Stafford Municipal School District RFP #20 - 003

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3/12/20

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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 performed by Paradigm Testing Laboratories., Report No. 19-1090, dated December 5, 2019.

1.3 REPORT

A. The Geotechnical Investigation Report bound herein is for Bidder's convenience and information only and is not a warranty of subsurface conditions.

B. The complete text of the Report may also be examined by qualified Bidders at the office of the Architect and where documents are on file for bidding purposes.

C. The Report is made available for Bidder's information only and is bound as part of the Contract Document.

D. 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 these design criteria will be considered or permitted.

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

Geotechnical Engineering Study
Stafford HS and STEM Magnet Renovation
Stafford Municipal School District
Stafford, Texas

Prepared For

Stafford Municipal School District
Stafford, Texas

Prepared By

Paradigm Consultants, Inc.
9980 W. Sam Houston Pkwy. South, Suite 500
Houston, Texas 77099
TBPE Reg. No. F-001478

December 2019

December 5, 2010
Paradigm Project No. 19-1090

Paradigm Consultants, Inc.

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Stafford Municipal School District
c/o Mr. Victor C. Fleming
Program Manager
Lockwood, Andrews & Newnam, Inc.
2925 Briarpark Drive
Houston, Texas 77042

Geotechnical Engineering Study
Stafford HS and STEM Magnet Renovation
Stafford Municipal School District
Stafford, Texas

Mr. Fleming:

Paradigm Consultants, Inc. presents this report of our geotechnical study for the above referenced project. This study was authorized with PO Number 038200 dated November 5, 2019.

We appreciate the opportunity to work with you during the design phase of this project and look forward to the opportunity to provide construction materials testing and monitoring services during the construction phase. If we may be of further assistance, please call us at your convenience.

Sincerely,

Ronald Gutierrez
Graduate Engineer

STATE OF TEXAS
FRANK S. ONG
83982
LICENSED
PROFESSIONAL ENGINEER
12-5-2010

Frank Ong, P.E.
Engineering Manager

Important Information about This

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.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in 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.

Geotechnical-Engineering 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 given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled*. No one except authorized client representatives 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 this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- 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. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed*. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation*.

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering 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 subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

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Important Information about your Geotechnical Engineering Report

INTRODUCTION

Paradigm Consultants, Inc. (Paradigm) presents this report of our geotechnical study the proposed Stafford HS and STEM Magnet Renovation in Safford, Texas. The renovation will include new corridor from the Magnet School to the Cafeteria and paving in front of the Library. This study was authorized with PO Number 038200 dated November 5, 2019.

The objectives of this study were to develop design recommendations and construction considerations for the proposed foundation and paving. Our study included the following tasks:

- Drilling and sampling three soil borings at selected locations within the project limits to explore the subsurface stratigraphy and groundwater levels;
- Performing geotechnical laboratory tests to aid in soil classification and determination of engineering properties of the encountered soils;
- Analyzing field and laboratory test data to develop geotechnical engineering design recommendations and construction considerations;
- Preparing this report presenting our findings and recommendations.

FIELD EXPLORATION AND LABORATORY TESTING

Our field exploration included drilling and sampling three borings. The approximate boring locations are shown on Figure 1. The borings were located in the field using the proposed development plan and existing landmarks.

Drilling Operations

ACE Drilling, a subcontractor to Paradigm, drilled and sampled the soil borings on November 22, 2019 using truck-mounted drilling equipment. Paradigm's field representative was on-site to monitor drilling activities, direct the sampling efforts, and log the boreholes. Our field operations were performed in general accordance with ASTM International (ASTM D 1452). Our field operations were performed in general accordance with ASTM International (ASTM D 1452[1]).

Soil Sampling

Soil was sampled continuously at 2-ft intervals to 12-ft depth with additional samples taken at 5-ft interval to the completion depth of the boring. The sampling method is determined based on the anticipated soils.

Soils interpreted to be cohesive soils (clay) during field operations were sampled by hydraulically pushing a 3-in. diameter, thin-walled steel tube a distance of about 24 in. Our field sampling procedures were in general accordance with ASTM D 1587.[2] For each recovered sample, our representative extruded the sample in the field, visually classified the soil, and measured the penetration resistance using a pocket penetrometer. A representative portion of the recovered sample was wrapped in aluminum foil and placed into a plastic bag for transport to our laboratory.

Water-Level Measurements

Drilling protocol includes dry augering from ground surface to the depth where water or borehole sidewall instability occurs. If neither water nor instability is encountered, dry-auger drilling techniques are used to the full depth of the boring. If water is encountered, the water level within the borehole is measured at 5-minute intervals for at least 15 minutes before drilling resumes using wet rotary methods.

Laboratory Testing

Paradigm performed geotechnical laboratory tests in general accordance with ASTM methods on selected soil samples to aid in soil classification and determine engineering properties. The test methods performed are presented in Table 1.

Table 1: Laboratory Test Methods

Test Name	Test Method
Moisture Content	ASTM D 2216[3]
Liquid and Plastic Limits and Plasticity Index	ASTM D 4318[4]
Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soil	ASTM D 2850[5]

Boring Logs

Paradigm's field representative logged each soil boring recording the drilling method, sampling method and interval, and penetration resistance. Details of the stratigraphic conditions encountered at each boring location were recorded on the field log in general accordance with ASTM D 5434.[6] Identification and descriptions of the soils were based on visual-manual procedures described in ASTM D 2488.[7]

The boring logs were developed using the stratigraphic and soil property data obtained during our field exploration and laboratory testing programs. Each log represents our interpretation of general soil and water conditions at the boring location. The boring logs include the type and interval depth for each sample, the corresponding penetration resistance, and the results of the index properties and strength testing. Soil classifications were based on the Unified Soil Classification System (ASTM D 2487[8]). The boring logs and a key to the terms and symbols used on the logs are included in Appendix.

When a penetration resistance value of 4.5 tsf is recorded and penetration resistance is used to determine soil consistency, Paradigm describes consistency as very stiff to hard. In the absence of unconfined compressive strength data, Paradigm does not expressly state that soil is hard consistency. In the absence of the appropriate field and/or laboratory test data at the interval depth, no estimate of consistency or density is noted.

Unified Soil Classification System. ASTM D 2487 classifies soil as either fine-grained or coarse-grained with the percentage of soil particles finer than the No. 200 sieve size used to differentiate between coarse-grained and fine-grained soil. Clay and silt are fine-grained soils and have 50% or more of their particles finer than the No. 200 sieve size. Gravel and sand are coarse-grained soils and have less than 50% of their particles finer than the No. 200 sieve size.

Clay has a plasticity index (PI) of 4 or greater and the plot of plasticity index versus liquid limit falls on or above the “A” line of the plasticity chart. Silt typically has a PI less than 4 and the plot of plasticity index versus liquid limit falls below the “A” line of the plasticity chart. For clay and silt, the descriptor “with sand” is used if 15% to 30% of the particles are sand size. If more than 30% of the particles within a clay or silt sample are sand size, the descriptor “sandy” is used. Fat clay has a liquid limit greater than or equal to 50, and lean clay has a liquid limit less than 50. Silty clay (CL-ML) has a PI between 4 and 7.

SURFACE AND SUBSURFACE CONDITIONS

General surface conditions were noted during our field exploration program. Subsurface conditions were evaluated by drilling three exploratory soil borings within the project site. Discussions of the site, subsurface and groundwater conditions encountered during our field exploration are presented in the following sections.

Surface Conditions

The site is generally level and covered with grass. Surface conditions at the boring locations and along the routes taken to access the boring locations were firm.

Subsurface Conditions

The subsurface soils, based on intercepted soils from three exploratory soil borings, consist of fat clay within the 20-ft explored depth. Additional details of encountered soils with laboratory test results are presented on boring logs in Appendix.

Groundwater was not encountered during our field exploration. Short-term water level observations should not be interpreted to represent long-term conditions. Water levels vary seasonally and with climatic conditions.

Expansiveness of Soils Encountered. The clays within the anticipated zone of seasonal moisture change, the existing ground surface to a depth of 5 ft, have a very high swell/shrinkage potential (Holtz & Gibbs[9], Raman[10], and Chen[11]), as shown in Table 2. PIs for the tested clays within the upper 10-ft depth ranged from 38 to 51.

Table 2: Potential for Expansion

Expansion Potential	Plasticity Index Range	Liquid Limit Range
Low	**PI<18**	**----**
Medium	**15 ≤ PI ≤ 28**	**35 ≤ LL ≤ 50**
High	**25 ≤ PI ≤ 41**	**50 ≤ LL ≤ 70**
Very High	**PI > 35**	**LL > 70**

FOUNDATION RECOMMENDATIONS

The foundation system for the proposed structures must satisfy two independent engineering criteria with respect to foundation soils. First, the foundation system should be designed with an appropriate factor of safety against failure of the foundation soils. Second, the movement to the foundation system due to compression (consolidation) or expansion (swell) of the soils supporting the foundation system must be within tolerable limits for the structure.

Foundation Design

The field and laboratory data acquired indicate that competent soils were encountered within the 20-ft depth explored. Recommended foundation design parameters for a drilled pier foundation system are outlined in Table 3.

Table 3: Foundation Design Parameters

Parameter	Recommendation	Comments
Foundation Type	Drilled-and-Underreamed Pier	
Bearing Depth, ft	14	Below existing grade
Bearing Material	Clay	
Net Allowable Bearing Pressure*****, q_{all}		
Total Load, kips/ft^2	4.5	Includes factor of safety (F.S.) of 2
Dead Load plus Sustained Live Load, kips/ft^2	3.0	Includes factor of safety (F.S.) of 3
Lateral Resistance, $q_{lateral}$, kips/ft^2	0.8	Includes F.S. of 3; neglect upper 4 ft
Pier (Footing) Spacing	At least two underream or shaft diameters; whichever is greater	Measured center-to-center
Bell to Shaft Ratio	3:1	2:1 or Straight-sided if sloughing is encountered
Pier Reinforcement	Minimum of 0.5% to 1% of concrete area	Extend the full depth of shaft and underream

Notes: * May be increased 33% for transient loading conditions such as wind.

Uplift capacity of the shallow drilled pier should be limited to the weight of the foundation plus the weight of soil above the foundation. A factor of safety of 2 should be applied when calculating the uplift resistance.

A bell-to-shaft ratio of 3:1 may be considered. If a 3:1 bell-to-shaft ratio in the pier excavation is not possible due to the presence of slickensided material at a location during construction, a reduced bell-to-shaft ratio or straight-sided shaft with a design bell diameter will be required.

Foundation Installation

Installation considerations include test pier, water conditions, reinforcing and concrete placement, and monitoring. These topics are discussed in the following sections.

Test Pier. We recommend test piers be drilled to verify the construction feasibility of drilled-and-underreamed piers, as planned. Test piers provide beneficial information for the contractor about cleaning, sloughing, and water conditions. Installation of underreamed piers may proceed provided the bearing surface is clean before concrete placement. If test piers are drilled, at least two piers should be installed across the site. The geotechnical engineer or his qualified representative should observe test pier installation.

Test piers should be drilled with the largest diameter shaft and bell with the largest bell to shaft ratio proposed for the project. The piers should extend to the recommended bearing elevation. Piers should be located within the footprint of the building but should not be located at working pier locations. Test piers may be backfilled with concrete, cement-stabilized sand, or flowable fill. Cement stabilized sand should meet a specification similar to Item 400 of TxDOT *Standard Specifications for Construction of Highways, Streets and Bridges.*[12] Flowable fill should meet a specification similar to Item 434 of *Specifications for the Construction of Roads and Bridges within Harris County*.[13] Excavated soil should not be used to backfill test piers. For planning purposes, test piers should remain open for 2 hr to evaluate sidewall stability. Production drilling may proceed immediately after test pier installation provided no difficulty is encountered during test pier installation.

Water Conditions. Based upon the observations during the field exploration, seepage into drilled-and-underreamed piers is not anticipated during the excavation. If water in excess of about 2 in. accumulates at the bottom of the excavation, the water should be pumped out before concrete placement. Water levels vary seasonally and with climatic conditions. Therefore, the contractor should verify that groundwater will not adversely affect pier installation prior to foundation construction.

Reinforcing and Concrete Placement. Reinforcing steel should be clean and free of any bond-inhibiting coating or mud. Reinforcing steel should be properly positioned and supported to assure the design concrete cover around the reinforcing steel is achieved. Before concrete placement, the bottom of each excavation should be cleaned. If water in excess of about 2 in. accumulates at the bottom of the excavation, the water should be pumped out before concrete placement.

Concrete should be placed in pier excavations within 2 hr after excavation to reduce the potential for soil sloughing and/or perched water seepage from the excavation walls. If sloughing soils are encountered in the excavation, it may be necessary to place reinforcing steel and concrete immediately after completion of excavation. Concrete should conform to applicable requirements of ACI 301,[14] ACI 318,[15] and ASTM C 94/C 94M.[16] The concrete slump should be 5 in. ± 1 in. Concrete should be placed with a tremie to direct the concrete toward the bottom of the foundation excavation. The concrete should not be allowed to ricochet off the walls of the excavation or the reinforcing steel. Pier design and placement should comply with the requirements of ACI 318, ACI 336.3R[17] and ACI 336.1.[18]

Monitoring. Depth to competent bearing soils is based on conditions encountered at the boring locations. Significant variations can occur over short horizontal distances from the boring locations. Our representative should be present during foundation construction to verify that the proper bearing stratum has been reached, the pier dimensions are as designed, the reinforcing steel is as specified, and that the excavation is clean and dry before reinforcing and concrete placement.

Foundation Performance

The recommended depth of the pier foundation system is predicated on existing and anticipated soil and water conditions. It is generally acknowledged that the depth of seasonal moisture change or “active zone” in the Houston and surrounding areas is about 10 ft below grade. That is, the moisture content of the soils to that depth undergo moisture fluctuations caused by climatic conditions often characterized by cycles of dry then wet weather. In addition, geotechnical engineers have documented that factors other than climate can exert an influence to much greater depths. Instances of trees affecting subgrade moisture as far as 15 to 20-ft below the ground surface have been reported. The recommended bearing depth of the pier foundations will provide protection of the piers from significant influence by seasonal moisture change but will not necessarily provide protection from non-climatic factors. Discussions of climatic and non-climatic factors affecting foundation performance as well as site specific factors are presented in the Slab Performance section of this report.

CONNECTION TO EXISTING STRUCTURE

There are several issues that must be considered for the proposed new corridor; the flexibility of connecting a new structure to an existing structure and the potential of interfering with an existing footing. It is recommended that the new structure not be structurally connected to the existing structure.

The existing structures have been in place for a period sufficient to have allowed the structure to settle under its own weight. The soil supporting the new structure will undergo immediate or short-term settlement in response to the weight of the structure. For this reason, all hard connections that will cross or span over the area between the existing canopy and the new structure should be made as late in the construction process as practical. This will allow relative movement to occur before making connections.

Prior to construction, the location and depth of the existing foundation system should be determined from as-built drawings of the original construction and verified in the field. During design, the new foundations should be located about 10 ft clear distance from an existing foundation to reduce pressure interaction in the soils below the old and new foundations. This distance will also help to reduce the chance of undermining the existing foundation during construction.

PAVEMENT RECOMMENDATIONS

We understand that the pavement for the parking lot will be concrete paving. Design, material requirements, and maintenance considerations for the pavement and subgrade preparation are discussed in the following section.

Design Considerations

ACI 330R[19] was used as the basis for rigid pavement recommendations. The recommended concrete thicknesses have performed satisfactorily under similar use conditions and have an anticipated life of 15 to 20 years provided the paving sections are based on a properly prepared and stabilized subgrade as outlined in Subgrade Preparation.

Rigid Paving Section

Paving should consist of 5-in. thick hydraulic cement concrete paving for vehicle parking areas only, 6-in. thick concrete paving for passenger vehicle driveways, and 7-in. thick concrete paving for entrance, access to dumpster pads, and truck traffic areas. The pavement subgrade be stabilized with lime to an 8-in. depth. Subgrade stabilizations are presented in the *Site Development Considerations* section of this report.

Concrete Mixture. The concrete paving mixture should be proportioned to achieve a compressive strength of at least 3500 lb/in.^{2} at 28 days or a minimum flexural strength of 500 lb/in.^{2} in third-point loading (ASTM C 78[20]) at 7 days.

Joints. Although the ACI 330R addresses design and construction of joints to control cracking and facilitate construction, the Guide does not consider the possible effects of joint layout on subgrade performance. The following are some general notes regarding joint placement:

- Spacing between joints should comply with Table 3.5 below from ACI 330R:

Pavement thickness, in.	Maximum spacing, ft
4, 4.5	10
5, 5.5	12.5
6 or greater	15

  Note that joint spacing should not exceed 15 ft;

- Avoid doweled expansion joint with winged retention plate on pavements less than 8 in. thick;

- Panels between joints should be square, or nearly so, with the ratio of length to width no greater than 1.5;

- Isolation or doweled joints should be installed between the building or penetrations such as inlets or manholes and adjoining pavement;

- Isolation joints should be installed at junctions of pavement with walks, curbs, or other obstructions where independence of movement is needed;

- Install a joint at any change in direction;

- Joints should be installed perpendicular to tangent along curve in pavement, preferably at point of smallest diameter;

- Reinforce re-entrant corners with three #3 diagonal or corner bars;

- Do not allow joints intersections to form a “T”;

- Avoid, if possible, longitudinal joints in or near wheel paths, particularly where heavy vehicles are expected; and

- Avoid positioning joints where water flows along the joint since joint sealant is not 100% effective in sealing moisture infiltration. Water intrusion at joints is frequently a major contributor to subgrade damage and loss of subgrade support.

Distributed Steel Reinforcement and Dowels. Local practice is to use distributed steel reinforcement in hydraulic cement concrete pavements to control opening of intermediate cracks that develop between joints in response to shrinkage, temperature differentials, uneven subgrade support, or load-related stresses. The function of the distributed steel is to hold together the crack's fracture faces.

ACI 330R addresses distributed steel reinforcement and provides an equation to determine the required area of distributed steel. Plain smooth dowels are recommended to provide load transfer across contraction joints while permitting the joints to move. ACI 330R contains recommendations for dowel size, length, and spacing. Avoid locating a dowel closer than three times the pavement thickness from a joint parallel to the dowel.

Maintenance. During the paving life, maintenance to seal surface cracks and reseal joints within concrete paving should be performed to achieve the desired paving life. Adequate drainage should be provided to prevent or retard influx of surface water from areas surrounding the paving. Water penetration into the pavement subgrade leads to paving degradation.

Subgrade Stabilization

The appropriateness of stabilizer and application rate for the subgrade should be determined at the time of construction. The paving subgrade can be lime stabilized to an 8-in. depth. An application rate of 48 lb/yd^2 of hydrated lime may be used for planning purposes. This application rate corresponds to 7% hydrated lime. Texas Department of Transportation (TxDOT) Specifications, Item 260, can be used as procedural guide for placing, mixing, and compacting the stabilizer and the soils.

Stabilized soils should be compacted to at least 95% of the maximum dry density determined by standard effort (ASTM D 698[21]). The moisture content should be at 3% wet of the optimum moisture content. Paving should be placed within 14 days to prevent deterioration of the prepared subgrade, or the subgrade should be sealed with an emulsion-based sealer.

CONSTRUCTION OBSERVATION

As dictated by common practice, our geotechnical engineering analysis and recommendations are based on the information on the subsurface conditions obtained from small diameter, widely-spaced borings and our judgment based on our education and experience. Because the borings indicate subsurface conditions only at the specific locations and time and only to the depths penetrated, they do not necessarily reflect strata variations that may exist between boring locations. Therefore, the validity of the recommendations in this report is based in part on assumptions about the stratigraphy made by the geotechnical engineer. Because variations may not be evident until construction begins, Paradigm should be retained to observe foundation installation and perform construction materials monitoring and test, particularly earthwork construction, during the construction phase of the project.

Our involvement enables Paradigm's geotechnical engineer or his/her representative to monitor the foundation and earthwork activities and be available to personally evaluate unanticipated conditions, conduct additional tests, if necessary, and to provide alternative recommendations where appropriate. Therefore, our recommendations on issues such as final bearing elevation, depth of undercutting unsuitable materials, and appropriateness of subgrade stabilization agent and quantity should be considered preliminary until actual subsurface conditions are revealed during construction.

LIMITATIONS

Opinions, conclusions, and recommendations presented in this geotechnical engineering report are based on the data obtained from the field and laboratory programs, our interpretation of the data, and information received from our client and construction professionals associated with the project. If changes in the nature, design, or location of the project are made, the opinions, conclusions, and recommendations contained in this report are not valid unless the changes are reviewed by Paradigm and the recommendations included within this report are modified or verified in writing by Paradigm. If subsurface conditions different from those described are noted during construction, recommendations in this report must be reevaluated.

The scope of our services did not include environmental assessment, compliance with applicable laws, geologic faults, and wetlands. Our scope did not include the investigation, detection, or design related to the presence of any biological pollutants. The term "biological pollutants" include, and is not limited to, mold, fungi, spores, bacteria, and viruses, and the byproducts of any such biological organisms.

Design Review

Paradigm should review the design drawings and specifications before being released for construction. Our review will confirm that the geotechnical recommendations and construction criteria presented in this report have been correctly interpreted and implemented. Paradigm is not responsible for any claims, damages, or liability associated with non-compliance with or misinterpretation of the recommendations and construction criteria presented in our geotechnical report. Design review is not within the scope of services authorized in this study. We would be pleased to submit a budget for this activity.

Standard of Care

This study was performed in a manner consistent with the level of care and skill ordinarily exercised by reputable geotechnical engineers practicing contemporaneously in the local area. No warranty or guarantee, express or implied, is made or intended.

Report Reproduction

Paradigm's report was prepared exclusively for the Stafford Municipal School District and its project team for use in preparing design and construction documents. This report shall not be reproduced or used for any other purpose without Paradigm's express written authorization. If included in construction documents, the report should be provided in its entirety with the caveat that it is included as a construction reference. Specific project requirements including options selected from this report must be obtained from the design drawings and specifications.

REFERENCES

1. ASTM D 1452-16 “Standard Practice for Soil Investigation and Sampling by Auger Borings,” Annual Book of ASTM Standards, Part 04.08, ASTM International, West Conshohocken, PA.

2. ASTM D 1587-15 “Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes,“ *Annual Book of ASTM Standards,* Part 04.08, ASTM, West Conshohocken, PA.

3. ASTM D 2216-19 "Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass," *Annual Book of ASTM Standards*, Part 04.08, ASTM, West Conshohocken, PA.

4. ASTM D 4318-17 "Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soil," *Annual Book of ASTM Standards*, Part 04.08, ASTM, West Conshohocken, PA.

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15. ACI Committee 318, "Building Code Requirements for Reinforced Concrete (ACI 318-19)," and "Commentary (ACI 318R-14)," ACI International, Farmington, MI.

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17. ACI Committee 336, "Specification for Construction of Drilled Piers," (ACI 336.3R-14), ACI International, Farmington, MI.

18. ACI Committee 336, "Design and Construction of Drilled Piers," (ACI 336.1R-01), ACI International, Farmington, MI.

19. ACI Committee 330, "Guide for Design and Construction of Concrete Parking Lots (ACI 330R-08)," ACI International, Farmington, MI.

20. ASTM C 78-18 “Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third Point Loading),” *Annual Book of ASTM Standards,* Part 02.06, ASTM, West Conshohocken, PA.

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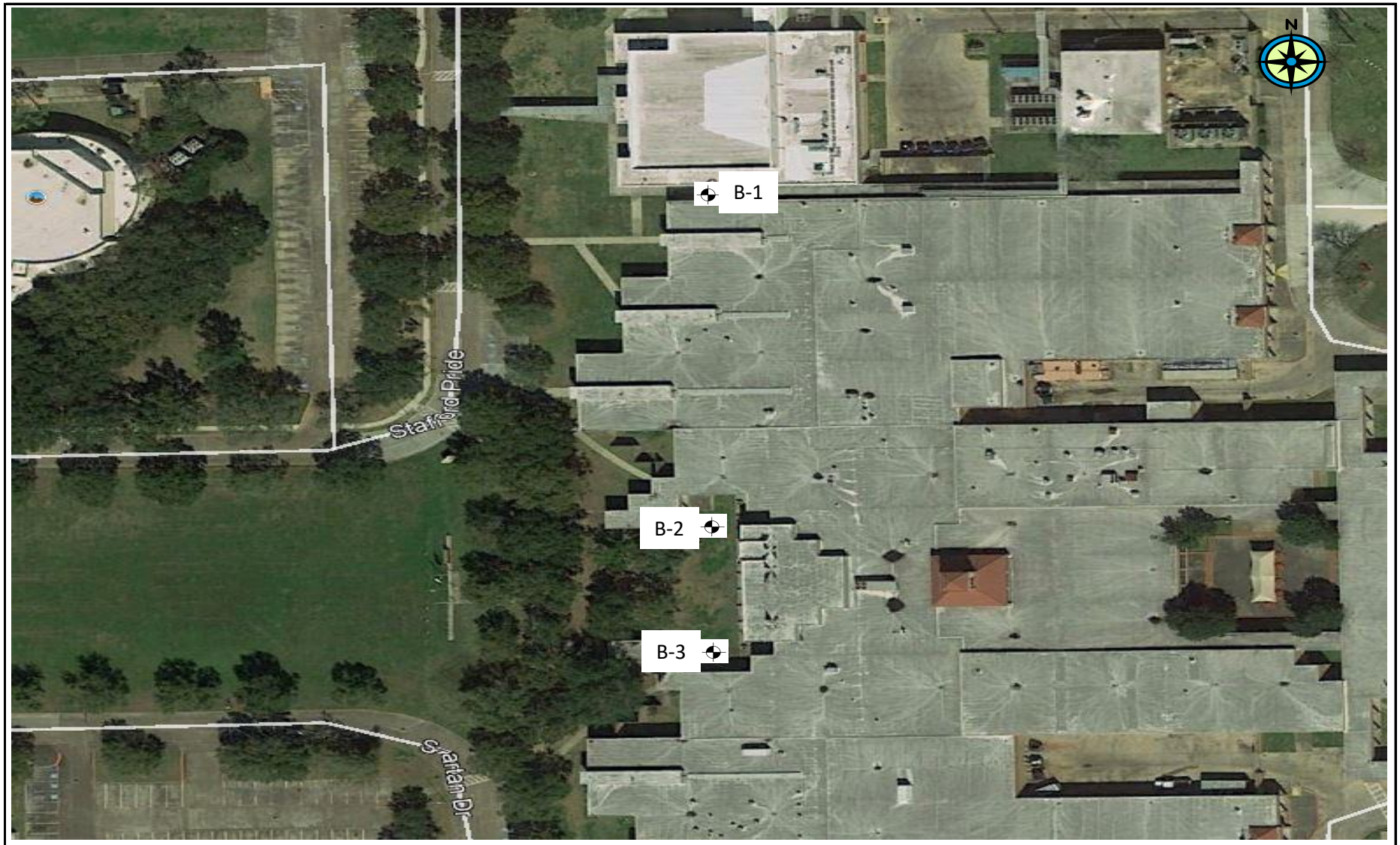

Reference: Base map provided by Google Earth
Note: Boring locations are approximate
Legend: ⌖ Boring location

STAFFORD HS AND STEM MAGNET RENOVATION STAFFORD MUNICIPAL SCHOOL DISTRICT STAFFORD, TEXAS	**Paradigm Consultants, Inc.** 9980 West Sam Houston Parkway South, Suite 500 Houston, Texas 77099
LOCKWOOD, ANDREWS & NEWNAM HOUSTON, TEXAS	PROJECT NO. 19-1090 FIGURE 1 PLAN OF BORINGS

Appendix

SOIL BORING LOGS

LOG OF BORINGS

Project: Stafford HS and STEM Magnet Renovation
Stafford Municipal School District
Stafford, Texas
Client: Lockwood, Andrews & Newnam, Inc.
Houston, Texas

Project No.: 19-1090
Boring Number: 1
Surface Elevation:
Drilled: 11/22/19 - 11/22/19
Sheet 1 of 1

Drilling Method(s):
Dry-auger drilling: 0 ft to 20 ft

Borehole Water Levels:
First encountered: No water encountered
After elapsed:

Depth, ft	Sample Interval, Sampler Type	Penetration Resistance, P, tsf / Standard Penetration Test N, blows/ft or blows/interval	Moisture Content, %	Finer than No. 200 sieve, %	Liquid Limit LL	Plastic Limit PL	Plasticity Index PI	Dry Density, lb/ft³	Undrained Shear Strength, c_u, lb/ft²	Failure Strain, %	Confining Pressure, lb/in²	Comment	DESCRIPTION OF STRATUM
		P = 1.0	35.3		72	21	51						FAT CLAY (CH): Stiff to very stiff, dark gray and brown.
1													- with root fibers, 0 to 4 ft.
2		P = 2.75	25.0		72	22	50						
3													
4		P = 1.75	27.6										- with ferrous stains, 4 to 6 ft.
5													- becoming brown and gray, 4 to 8 ft.
6		P = 1.75	26.6										
7													
8		P = 3.25	20.4		56	18	38	110	2920	11.6	10	Bulge, Vertical Fracture, Slickensided	- becoming reddish brown with ferrous stains and calcareous nodules, 8 to 20 ft.
9													- with silt, 8 to 15 ft.
10													
11													
12													
13		P = 3.75	25.7					100	2610	3.6	15	Bulge, Vertical Fracture, Slickensided	
14													
15													
16													
17													
18		P = 3.0	25.4										
19													
20													

Remarks:

Borehole terminated at 20-ft depth

LOG OF BORINGS

Project: Stafford HS and STEM Magnet Renovation
Stafford Municipal School District
Stafford, Texas
Client: Lockwood, Andrews & Newnam, Inc.
Houston, Texas

Project No.: 19-1090
Boring Number: 2
Surface Elevation:
Drilled: 11/22/19 - 11/22/19
Sheet 1 of 1

Drilling Method(s):
Dry-auger drilling: 0 ft to 5 ft

Borehole Water Levels:
First encountered: No water encountered
After elapsed:

Soil Symbol	Depth, ft	Sample Interval, Sampler Type	Penetration Resistance, P, tsf Standard Penetration Test N, blows/ft or blows/interval	Moisture Content, %	Finer than No. 200 sieve, %	Liquid Limit LL	Plastic Limit PL	Plasticity Index PI	Dry Density, lb/ft³	Undrained Shear Strength, c_u, lb/ft²	Failure Strain, %	Confining Pressure, lb/in²	Comment	DESCRIPTION OF STRATUM
			P = 2.5	21.6										FAT CLAY (CH): Very stiff to hard, dark brown.
	1													- with root fibers, 0 to 2 ft.
	2		P = 4.5+	24.7		70	24	46						- with silt, 2 to 4 ft.
	3													
	4		P = 4.5+	24.3					98	4360	6.8	5	Bulge, Vertical Fracture, Slickensided	- becoming dark gray and brown with root fibers, 4 to 5 ft.
	5													

Remarks:

Borehole terminated at 5-ft depth

LOG OF BORINGS

Project: Stafford HS and STEM Magnet Renovation
Stafford Municipal School District
Stafford, Texas
Client: Lockwood, Andrews & Newnam, Inc.
Houston, Texas

Project No.: 19-1090
Boring Number: 3
Surface Elevation:
Drilled: 11/22/19 - 11/22/19
Sheet 1 of 1

Drilling Method(s):
Dry-auger drilling: 0 ft to 5 ft

Borehole Water Levels:
First encountered: No water encountered
After elapsed:

Soil Symbol	Depth, ft	Sample Interval, Sampler Type	Penetration Resistance, P, tsf Standard Penetration Test N, blows/ft or blows/interval	Moisture Content, %	Finer than No. 200 sieve, %	Liquid Limit LL	Plastic Limit PL	Plasticity Index PI	Dry Density, lb/ft³	Undrained Shear Strength, c_u, lb/ft²	Failure Strain, %	Confining Pressure, lb/in²	Comment	DESCRIPTION OF STRATUM
			P = 1.0	33.6		59	20	39						FAT CLAY (CH): Stiff to very stiff, dark brown.
	1													- with ferrous stains, 0 to 2 ft.
	2		P = 2.5	29.6					94	1960	2.9	4	Bulge, Vertical Fracture, Slickensided	- with root fibers, 0 to 4 ft.
	3													
	4		P = 1.5	26.7										- becoming gray and brown, 4 to 5 ft.
	5													

Remarks:

Borehole terminated at 5-ft depth

KEY TO BORING LOG TERMS AND SYMBOLS

MATERIAL SYMBOLS

Fat Clay (CH)
Lean Clay (CL)
Sandy Lean Clay (CL)
Silty Clay (CL-ML)
Silt (ML)
Sandy Silt (ML)
Elastic Silt (MH)
Organic Clay or Silt (OH) High Plasticity
Organic Clay or Silt (OL) Low Plasticity
Peat (PT)
Well Graded Sand (SW)
Poorly Graded Sand (SP)
Silty Sand (SM)
Clayey Sand (SC)
Well Graded Gravel (GW)
Poorly Graded Gravel (GP)
Silty Gravel (GM)
Clayey Gravel (GC)
Fill
Asphalt
Base
Concrete

SAMPLER SYMBOLS

Auger
Thin-walled tube
Split barrel
Core
No recovery

STANDARD PENETRATION TEST (SPT)

N = 25	The sampler was seated 6 in. with blows from a 140-lb hammer then 25 blows were required to advance the sampler through the two 6-in. intervals of the test. The "N" value is the sum of the blows needed to penetrate the final 12 in.
12, 26, 50/3"	The sampler was seated 6 in. by 12 blows from a 140-lb hammer then 76 blows were required to advance the sampler a distance of 9 in. Full penetration of 12 in. below the seating interval could not be achieved before the 50 blow limit was recorded in one interval.
50/4"	Sampler was driven 4 in. of the 6-in. seating interval by blows of a 140-lb hammer before the 50 blow limit was reached.

WATER SYMBOLS

Depth where water was first encountered during drilling

Depth where water was encountered within the open borehole after completion of drilling (see log for elapsed time)

DESCRIPTIVE TERMS

Fine-Grained
(Major portion passing No. 200 sieve)
Silt and Clay

Consistency	Undrained Shear Strength, ksf	SPT "N" Value
Very soft	Less than 0.25	Less than 2
Soft	0.25 to 0.50	2 to 4
Firm	0.50 to 1.00	4 to 8
Stiff	1.00 to 2.00	9 to 15
Very stiff	2.00 to 4.00	15 to 30
Hard	Greater than 4.00	Greater than 31

Coarse-Grained
(Major portion retained on No. 200 sieve)
Gravel and Sand

Description	Relative Density	SPT "N" Value
Very loose	0 to 15%	Less than 4
Loose	15% to 35%	4 to 10
Medium dense	35% to 65%	10 to 30
Dense	65% to 85%	30 to 50
Very dense	85% to 100%	Greater than 50

PCI's geotechnical engineer reviewed and compiled the field and laboratory data to develop each boring log. Each log represents our interpretation of general soil and water conditions at the boring location. Strata lines on the log may be transitional and are approximate in nature. Water levels refer only to those conditions observed at the time and location indicated.

01 10 00

SUMMARY

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
1. Project information.
2. Work covered by the Contract Documents.
3. Contractor duties.
4. Work by Owner.
5. Work under separate contracts.
6. Owner-furnished products.
7. Access to site.
8. Protection of work and property.
9. Owner's occupancy requirements.
10. Specification formats and conventions.
11. Provisions for electronic media.

B. Related Sections include the following:
1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: Renovations to Existing Stafford High School and Adaptation of Old Stafford Middle School to serve as a Magnet School.
1. Project Location: Stafford, Texas

B. Owner Identification: Stafford Municipal School District (Stafford MSD)

C. Architect Identification: The Contract Documents were prepared for the Project by AUTOARCH Architects, LLC, 6200 Savoy, Suite 100, Houston, TX 77036.
1. Contact: Lina Sabouni
a. Telephone: (713) 952 – 3366.
b. Email: lina@autoarch.net

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of the Project is defined by the Contract Documents and consists of the following:
1. Construction of a one-story, wood framed office building with approximately 4,500 sf of floor area and including related site improvements.
2. Shall conform to and coordinate with Uniform General, Supplemental and Special Conditions.
3. Drawings will be available to Contractor in PDF format for Contractor’s use and distribution to subcontractors and suppliers.

B. Project will be constructed under a single general construction contract

1.4 CONTRACTOR DUTIES

A. VOC Compliance: Ensure that all assemblies, components, and systems comply with all

VOC (Volatile Organic Components) requirements and regulations of the Environmental Protection Agency (EPA) Occupational Safety Health Administration (OSHA), State, County, City, and Local Air Control District.

B. Except as specifically noted, provide and pay for:
   1. Labor, materials, and equipment.
   2. Tools, construction equipment and machinery.
   3. Water, heat, and utilities required for construction.
   4. Other facilities and services necessary for proper execution and completion of work.

C. Secure and pay for, as necessary for proper execution and completion of Work, and as applicable at time of receipt of bids:
   1. Building Permit.
   2. Licenses.
   3. Bonds

D. Give required notices.

E. Comply with all applicable local Building Codes, ordinances, rules, regulations, orders and other legal requirements of public authorities which bear on performance of Work.

F. Promptly submit written notice to Architect of observed variance of Contract Documents from requirements of authorities having jurisdiction. Assume responsibility for Work performed without such notice known to be contrary to code or regulatory requirements.

1.5 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.

B. Preceding Work: Owner will not perform any construction operations at Project site. Those operations are scheduled to be substantially complete before work under this Contract begins.
   1. Data Switches, and Security System Cabling and Security Equipment Installation. [Project Director and/or Architect may attach as appropriate detailed Equipment Responsibility Matrix.]
   2. Interior and exterior signage and water leak testing.

C. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.
   1. Telephone Equipment, Audio Visual, Surveying, Geotechnical Study, Materials Testing, Test and Balance of HVAC System. Furniture and OPOI, FFE. [*Project Director and/or Architect may attach as appropriate detailed Equipment Responsibility Matrix.]*

D. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory work under this Contract.
   1. Materials testing, install interior and exterior signage and water leak testing.

1.6 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

1.7 OWNER-FURNISHED, CONTRACTOR-INSTALLED PRODUCTS (REFER TO ARCHITECT PROGRAM AND DRAWINGS)

A. Owner's and Contractor's Responsibilities:
1. Contractor shall provide support systems to receive Owner's equipment as well as plumbing, HVAC, and electrical connections.
2. Owner will arrange for and deliver Shop Drawings, Product Data, and Samples to Contractor.
3. Owner will arrange and pay for delivery of Owner-furnished items according to Contractor's Construction Schedule.
4. After delivery, Owner will inspect delivered items for damage. Contractor shall be present for and assist in Owner's inspection.
5. If Owner-furnished items are damaged, defective, or missing, Owner will arrange for replacement.
6. Owner will arrange for manufacturer's field services and for delivery of manufacturer's warranties to Contractor.
7. Owner will furnish Contractor the earliest possible delivery date for Owner-furnished products. Using Owner-furnished earliest possible delivery dates, Contractor shall designate delivery dates of Owner-furnished items in Contractor's Construction Schedule.
8. Contractor shall review Shop Drawings, Product Data, and Samples and return them to Architect noting discrepancies or anticipated problems in use of product.
9. Contractor is responsible for receiving, unloading, handling, and storing Owner-furnished items at Project site.
10. Contractor is responsible for protecting Owner-furnished items from damage during storage and handling, including damage from exposure to the elements.
11. If Owner-furnished items are damaged as a result of Contractor's operations, Contractor shall repair or replace them with new items.
12. Contractor shall install and otherwise incorporate Owner-furnished items into the Work, including making building services connections.

1.8 ACCESS TO SITE

A. Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.Make each entity engaged in work on the project aware that the adjacent buildings house operating facilities that must continue in operation during the construction period, except as the Architect and Owner may otherwise direct.

B. Confine operations at site to areas permitted by Law, Ordinances, Permits, and Contract Documents.

C. Do not unreasonably encumber site with materials or equipment.

D. Assume full responsibility for protection and safekeeping of products stored on premises.

E. Move any stored products which interfere with operations of Owner or other contractors.

F. Obtain and pay for use of additional storage or work areas needed for operations.

G. Limit use of site for work and storage as follows:
1. Do not use completed paving areas for storage without Owner's approval.
2. Do not store materials where trees are located.
3. Restrict Work and storage to areas indicated on Drawings or approved by Owner.

4. Access site in areas approved by Owner.
5. Restrict parking to areas approved by Owner.
6. Do not perform operations that would interrupt or delay Owner's daily operations.

H. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

1.9 PROTECTION OF WORK AND PROPERTY

A. The Contractor shall maintain adequate protection of the Work from damage and shall protect the Owner's and adjacent property from injury or loss arising from the Work. Contractor shall provide and maintain at all times any OSHA-required danger signs, guards, and obstructions necessary to protect the public and construction personnel from any dangers inherent with or created by the Work in progress.
1. All federal, state, and city rules and requirements pertaining to safety, and all EPA standards, OSHA standards, and NESHAP regulations pertaining to asbestos as required shall be complied with.

B. Twenty-four (24) Hour Call: The Contractor shall have personnel on call 24 hours per day, for emergencies during the course of the Project. The Owner shall be provided with a 24-hour emergency contact number of Contractor’s personnel. Contractor shall be able to respond to any emergency call and have personnel on-site within two (2) hours after contact. Numbers to be made available to the Owner shall include home, office and mobile numbers for the following:
1. Contractor’s project manager.
2. Contractor’s field superintendent.
3. Owner or company officer of Contractor.

1.10 OWNER’S OCCUPANCY REQUIREMENTS

A. Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.

B. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of building.

1.11 SPECIFICATION FORMATS AND CONVENTIONS

A. General: Specification requirements are to be performed by Contractor unless specifically stated otherwise.
1. The Specifications do not:
a. Establish trade jurisdictions or divisions of responsibility.
b. Do not define Subcontract scopes of work.

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

C. Specification Format: The Specifications are organized into Divisions and Sections using the current version of CSI/CSC's "MasterFormat" 50-Division format and numbering system.
1. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the Table of Contents at the

beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.

2. The order of articles, paragraphs, subparagraphs, and sub-subparagraphs within the text any Specification section is defined by a sequence of indentations.
   a. Article, paragraph and subparagraph titles, and other identifications of subject matter in the Specifications, are intended as an aid in locating and recognizing various requirements in the beginning words of a sentence.
   b. Specification text shall govern over titling, and shall be understood to be and interpreted as a whole. Where a title establishes the subject, the titles are subordinate to and do not define, limit, or otherwise restrict the Specification text.
3. The captions and headings of various subdivisions of the Contract Documents are intended only as a matter of reference and convenience for describing the Work and in no way define, prescribe or limit the scope or intent of the Contract Documents or any subdivision thereof.

D. Specification Style: 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. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
   a. 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.
   b. Contract Documents may omit modifying words such as “all” or “any”, and articles such as “the” or “an”. The absence of a modifier or article from one statement that appears in another is not intended to affect the interpretation of either statement.

E. Specification Content: Drawings and general provisions of the Contract, including the Uniform General Supplemental and Special Conditions and Division 01 specification Sections, apply to the execution of the Work of subsequent specification sections, and vice versa.
1. Work specified in any one Section is related to, and dependent upon, Work specified in other Sections, whether or not specific reference is made to the Work of other Sections. Cross-references in the Specifications are general references intended as a matter of convenience for aiding in the location general information, and are not all-inclusive.
2. Names, telephone numbers, and web-site addresses and other contact information listed in the Contract Documents are for convenience only, are subject to change, and are believed to be accurate and up-to-date as of the printing of the Contract Documents.
3. Use of the word “including”, when following any general statement, shall not be construed to limit such statement to specific items or matters listed, whether or not non-limiting language (such as “without limitation”, “but not limited to”, or other words of similar import) is used with reference thereto; but rather, shall be deemed to refer to all other items or matters that could reasonably fall within the broadest possible scope of such general statement.

1.12 PROVISIONS FOR ELECTRONIC MEDIA

A. Project Website:
1. Construction Administration will be utilized through a Web-based Project Management System, Projectmates. This Owner-oriented management information system will provide a project participant the ability to track and manage the entire project. Projectmates will track communication between the Owner, Program Manager, Architect/Engineer, Design Consultants, Contractor and Subcontractors.
2. The Architect/Engineer shall manage and coordinate the on-going electronic Construction Documents, tracking changes and incorporating same and maintaining current Construction Documents. The Architect/Engineer shall make these available to the Contractor and Owner as required.
3. Projectmates key features that will be utilized are included but not limited to:
4. Advanced reporting capabilities for the Owner
5. Online RFIs and Submittals for the Contractor & Architect
6. Online Field Reports for field inspectors
7. Online Change Orders & contracts for the contract Manager
8. Project Detail tracking:
9. Notes
10. Tasks
11. Schedule
12. Meetings
13. Permits
14. Storm water (SWPPP)
15. Architect Field Observations
16. Payment applications
17. Constructability
18. Online Project Directory
19. Email-based alerts
20. Task Management
21. Site Photographs / Image Gallery
22. Multi-tiered User Access
23. Role-based security & permissions
24. Advanced error tracking
25. Final Project Archive

B. Electronic Drawing Documents:
1. Electronic file copies of the Contract Drawings in latest AutoCAD in electronic format approved by LSC format may be obtained from the Architect. Contact Architect to determine availability of CAD documents and costs.
2. Liability release and transfer agreement shall be executed and submitted by Contractor prior to turn-over of electronic files. Refer to Agreement Form included at end of Section 01 33 00.

PART 2 PRODUCTS - Not applicable to this Section

PART 3 EXECUTION - Not applicable to this Section

END OF SECTION

01 21 00

ALLOWANCES

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 governing allowances. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to the Contractor. Refer to the AIA 201 General Conditions and the Supplementary Conditions for additional requirements concerning allowances. If necessary additional requirements will be issued by Change Order.

1. Allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts.
2. Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, bonds, insurance and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances.
3. CAEA, AEA & CO will be issued by the A/E via Prolog (Potential Change Order Module)
4. To document and gain authorization to utilize contract contingency on a particular campus for items not covered in the original contract scope of work.
5. CAEA is used for authorization of the contingency included in the GC Contract.
6. AEA is used for authorization and tracking of use of contract allowances. A separate AEA series is used for each defined allowance.
7. Any needs beyond the means of the contract shall require Change Order(s).
8. CAEA shall only be used for necessary work authorized by the District and in addition to the contracts defined scope of work or to credit work deleted from the contract as authorized by the District.
9. Contract contingency is not an entitlement to the GC. Unused portions shall be removed from the contract via a final Change Order during contract closure. The goal is to not use contingency, it is not included to allow for upgrades or expansion of scope, but to cover un-foreseen issues and design omissions within the approved scope.
10. A CO is only used when no other funding sources are available within the contract and contract value must be added.
11. A CO is the only method for adding funding or to change the contract work (when funding from Owner's Contingency Allowance included in the Contract is depleted) or time.

B. Types of allowances include the following:

1. Lump-sum allowances.
2. Unit-Cost allowances
3. Quantity allowances
4. Owner Controlled Contingency allowances.

C. Related Sections:
   1. Division 00 Competitive Sealed Proposal Form - Base Bid.
   2. Division 01 Section "Unit Prices" for procedures for using unit prices.
   3. Divisions 02 through 49 Sections for items of Work covered by allowances.

1.3 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, Contractor shall advise Architect and Program Manager of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.

B. At Architect's or Program Manager’s request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.

C. Once the proposal is approved by the Owner, purchase products and systems selected by Architect from the designated supplier.

1.4 SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Contingency Allowance Expenditure Authorization (CAEA), Allowance Expenditure Authorization (AEA), or as specified in Change Order.

B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

C. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.

D. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.5 COORDINATION

A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.6 ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include freight, insurance, and delivery to Project site.

B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials under allowance shall be included as part of the Contract Sum and not part of the allowance.

C. List of Allowances on Project:
   1. Contingency Allowance, labeled Owner Betterment Allowance in the Bid Documents:
      a. 10% of the Base Proposal lump sum as indicated in the Bid Documents .

1.7 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a proposal based on the difference between purchase amount and the allowance.
   1. Include installation costs in purchase amount only where indicated as part of the allowance.

2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
3. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

A. Contingency Allowance Expenditure Authorization (CAEA) is a request for utilization of a specified portion of the contingency allowance included in the GC contract.

B. An Allowance Expenditure Authorization (AEA) is a request for utilization of a specified portion of an allowance included in the GC contract.

C. Each CAEA, AEA and CO must be listed separately in the pay application under the appropriate funding category.

D. Change Orders (CO) is a request for utilization of a specific portion of contingency dollars outside the GC contract and it is used when no other funding sources are available within the contract.

END OF SECTION

01 22 00

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 Sections:
1. Division 00 Competitive Sealed Proposal Form – Alternates and Unit Pricing.
2. Division 01 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
3. Division 01 Section "Quality Requirements" for general testing and inspecting requirements.

1.3 DEFINITIONS

A. Unit price 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 either increased or decreased.

1.4 PROCEDURES

A. A Unit Price is a cost for a unit of work, as described in the Proposal Documents. The Owner may add or deduct Unit Price work at the amounts stated on the Proposal Form and such amounts shall not be subject to additional mark-up by the Contractor or his Subcontractors.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. If the quantities of the items listed in the Schedule of Unit Prices are increased, the Unit Prices set forth by the Contractor shall apply to such increased quantities. Unit Prices for adjusting the Contract Sum for less work or material installation will be 95% of these amounts.

1.5 UNIT PRICES LIST

A. Site Work:
1. Add / Delete 60" Wide Sidewalks.
2. Add / Delete Non-Traffic Concrete Flatwork
3. Add / Delete Medium Duty (5") Concrete Paving.
4. Add / Delete 6" Concrete Curb.

B. Interior Finishes:
1. Demolish 12"x12" Vinyl Composition Tile.

2. Add / Delete 12”x12” Vinyl Composition Tile.

C. Electrical Power
1. Add / Delete 120V Duplex Rec. On Nearby Circuit.
2. Add / Delete 120V Duplex Rec. On Dedicated Circuit, including 20 amp circuit breaker.
3. Add / Delete 220V Rec. On Dedicated Circuit including 20 amp circuit breaker
4. Add / Delete Two-Way Light Switch
5. Add / Delete Two-Way Light Switch
6. Add / Delete J-Box with 1-1/4” Conduit stubbed to above ceiling

D. Data
1. Add / Delete Data Port Wired to Nearest IDF / MDF room.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

01 23 00

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 RELATED WORK

A. Related Work of Other Sections:
   1. Section 01 30 00 – Administrative Requirements: Requirements for coordination of submittals and installation of various portions of the Work.

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. 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. Alternates will be exercised at the option of Owner. Alternates accepted by Owner for incorporation into the Work are identified in the Owner-Contractor Agreement. Execute accepted alternates under the same conditions as other work of the Contract.

D. Execute accepted alternates under the same conditions as other work of the Contract.

E. 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 applicable to this Section

PART 3 EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Include cost to furnish and install the work described in each of the following Alternates in the amount stated in the Bid for each respective alternate:

1. Additive Alternate No. 01: If this Alternate is Chosen by the Owner, Provide and Install Work Indicated at CTE Kitchen in High School.
   a. Refer to Drawing A2.12 & Foodservice Drawings.
2. Additive Alternate No. 02: If this Alternate is Chosen by the Owner, Provide and Install Work Indicated at Welding Lab in High School.
   a. Refer to Drawings M1.07 & E2.05.
3. Additive Alternate No. 03: If this Alternate is Chosen by the Owner, Provide and Install Work Indicated at AV Room in High School.
   a. Refer to Drawing M1.05.
4. Additive Alternate No. 04: If this Alternate is Chosen by the Owner, Perform Demolition Work Indicated at CTE Multipurpose Space in High School.
   a. Refer to Drawings A2.12.

END OF SECTION

01 25 00

SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for submitting and processing product substitutions after execution of the Agreement.

B. For administrative and procedural requirements for product substitutions during the procurement process and prior to execution of the Agreement, refer to the Owner Provided Front End Documents.

C. Where the Owner Provided Front End Documents and Division 00 provide requirements for substitution that conflict with this section, the more stringent shall govern. The Architect shall interpret the requirements of these sections and shall be the final authority in deciding whether a substitution shall be accepted.
   1. Regardless of any conflict, the Substitution Request Form following this section must be completed by the Contractor for all substitution issues.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitution requests will only be considered prior to receipt of Bids except when a specified product or system is no longer available.
   2. Owner-requested cost-reduction proposals shall be submitted on Substitution Request Form.

1.3 DESIGN REQUIREMENTS

A. Materials, products, and equipment included in the Contract Documents are specified for the purpose of establishing a minimum standard of quality, cost, appearance, design, and function. It is not the intent to limit the acceptance of materials, products or equipment specified, but rather to name or describe a material, product or piece of equipment as the absolute minimum standard that is desired and acceptable. Where proprietary names are used, whether or not followed by the words "or acceptable substitution," requests for substitution will nevertheless be considered if properly submitted to and received by the Architect prior to the designated date.

1.4 SUBMITTALS

A. Substitution Requests after Award of Contract: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

B. The Substitution Request Form included as an attachment to this Document shall be used for all Substitution requests. Failure to use the attached Substitution Request form, or failure to fully execute the form as required, will result in rejection of the proposed substitution request without review.
   1. Do not make substitution request with shop drawings or product data submittals.

C. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
   1. Statement indicating why specified material or product cannot be provided.
   2. 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.
   3. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
   5. Samples, where applicable or requested.
   6. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
   7. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
   8. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
   9. 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 lack of availability or delays in delivery.
   10. Cost information, including a proposal of change, if any, in the Contract Sum.
   11. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
   12. 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.
   13. Only one substitution request will be reviewed for each product or system.

PART 2 PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Timing: Architect will consider requests for substitution if received within 60 days after award of Contract. Requests received after that time may be considered or rejected at the discretion of Architect.

B. 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:
   1. 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.
   2. Requested substitution does not require extensive revisions to the Contract Documents.
   3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
   4. Substitution request is fully documented and properly submitted.
   5. Requested substitution will not adversely affect Contractor's Construction Schedule.
   6. Requested substitution has received necessary approvals of authorities having jurisdiction.

7. Requested substitution is compatible with other portions of the Work.
8. Requested substitution has been coordinated with other portions of the Work.
9. Requested substitution provides specified warranty.

C. Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:
1. Evidence that the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
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, 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

3.1 CONTRACTOR RESPONSIBILITIES

A. All requests shall originate from the Contractor. Manufacturers, manufacturer's representatives, dealers, distributors, suppliers, and subcontractors shall not direct or make requests to substitute equipment or materials.

B. Substitutions shall be submitted to the Architect only; no substitutions shall be submitted directly to any consultant, the Owner, or any of the Owner’s consultants.

C. All requests for substitutions shall be accompanied by manufacturer's product data, specifications, drawings, catalog cuts, samples, installation instructions, performance data, list of projects completed of similar size and scope, and other references and information necessary to completely describe the item, and to facilitate a thorough and complete review by the Architect. Requests not meeting all these requirements may be rejected without evaluation.

3.2 ARCHITECT’S ACTION

A. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week 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 7 days of receipt of additional information or documentation, whichever is later.

B. 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. 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. In proposing items for consideration, Contractor assumes all risk, costs, and responsibility for item's final acceptance, compliance with the Contract Documents, integration into the Work, and performance.

3.3 IMPLEMENTATION

A. Form of Acceptance: Change Order.

B. If Architect cannot make a decision on use of a proposed substitution within time allocated,

or if substitution request is rejected, provide the basis of design product originally specified.

C. If an accepted substitution is later found to be not in compliance with the Contract Documents, Contractor shall remove the substituted product, material, or item and provide the originally-specified product at no additional cost to Owner.

3.4 ATTACHMENTS

A. Refer to Section 01 25 00x for Post-Award Substitution Request Form.

END OF SECTION

01 25 00x

SUBSTITUTION REQUEST FORM

(After Contract Award)

PROJECT: _____

TO: _____

FROM: _____

_____

NO.: _____

DATE: _____

Contractor hereby requests acceptance of the following product or system as a substitution in accordance with provisions of Section 01 25 00 of the Specifications:

1. SPECIFIED PRODUCT OR SYSTEM

Substitution request for: _____

Specification Section No.: _____ Article / Paragraph: _____

2. REASON FOR SUBSTITUTION REQUEST

SPECIFIED PRODUCT:

☐ Is no longer available

☐ Is unable to meet Project Schedule

☐ Is unsuitable for the designated application

☐ Cannot interface with adjacent materials

☐ Is not compatible with adjacent materials

☐ Cannot provide the specified warranty

☐ Cannot be constructed as indicated

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

☐ Strike ☐ Bankruptcy of manufacturer or supplier

☐ Lockout ☐ Similar occurrence (explain below)

☐ Will reduce construction time

☐ Will result in cost savings of $_____ to project

☐ Is for supplier's convenience

☐ Is for subcontractor's convenience

☐ Other: _____

3. SUPPORTING DATA

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

☐ Sample is attached. ☐ 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:	_____	_____
Catalog No.:	_____	_____
Vendor:	_____	_____
Variations:	_____	_____

(Add Additional Sheets If Necessary)

Local Distributor or Supplier: _____

Maintenance Service Available: ☐ Yes ☐ No Warranty: ☐ Yes ☐ No _____ Years

Available Warranty Exceeds that of Specified Product: ☐ Yes ☐ No

Spare Parts Source: _____

5. PREVIOUS INSTALLATIONS

Identification of at least **four** similar projects on which proposed substitution was used:
Note: All questions must be answered and all blanks filled in.

PROJECT #1:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #2:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #3:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #4:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

6. EFFECT OF SUBSTITUTION

Proposed substitution affects other work or trades: ☐ No ☐ Yes (if yes, explain)

_____

_____

Proposed substitution requires dimensional revisions or redesign of architectural, structural, M-E-P, life safety, or other work: ☐ No ☐ 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 ordi-nances;

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 (at-tached);

F. They will pay any redesign fees incurred by the Architect or any of the Archi-tect'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 sub-mitted 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 recon-sideration as additional data, materials, workmanship, and coordination with other work are observed and reviewed.

Bidding Contractor: _____
(Name of prime bidding contractor)

Date: _____ By: _____

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

8. ARCHITECT'S REVIEW AND ACTION

☐ Substitution is accepted.

☐ Substitution is accepted, with the following comments: _____

_____

☐ Resubmit Substitution Request; Provide more information in the following areas:

- ☐ Provide proposal indicating amount of savings / credit to Owner
- ☐ Bidding Contractor shall sign Bidder's Statement of Conformance
- ☐ Bidding Subcontractor shall sign Bidder's Statement of Conformance
- ☐ Other: _____

_____

☐ Substitution is not accepted:

- ☐ Substitution Request received too late.
- ☐ Substitution Request received directly from subcontractor or supplier.
- ☐ Substitution Request not submitted in accordance with requirements.
- ☐ Substitution Request Form is not properly executed.
- ☐ Substitution Request does not indicate what item is being proposed.
- ☐ Insufficient information submitted to facilitate proper evaluation.
- ☐ Proposed product does not appear to comply with specified requirements.
- ☐ Proposed product will require substantial revisions to Contract Documents.

Architect

Date: _____ By: _____

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

☐ Substitution is accepted. Architect to prepare Change Order.

☐ Substitution is not accepted.

☐ Owner will pay Architect directly for redesign fees.

☐ Include Architect Additional Service fee for implementing the substitution in the Change Order.

Date: _____ By: _____
(Owner's Representative)

END OF SECTION

01 26 13

REQUESTS FOR INFORMATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes administrative provisions for submitting and processing Requests for Information (RFIs) after execution of the Agreement:

1.2 DEFINITIONS

A. RFI: Request from Contractor seeking Information or clarification of the Contract Documents.

1.3 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS

A. General: Carefully study and compare Contract Documents with existing conditions at Project site and shall at once report in writing to Architect any error, inconsistency or omission discovered or any materials, systems, procedures, or methods of construction, either shown on the Drawings or specified, which the Contractor feels are incorrect, inadequate, obsolete, or unsuitable for purpose intended.

B. Before starting each portion of the Work, carefully study and compare the various Drawings and other Contract Documents related to that portion of the Work, and information furnished by the Owner, take field measurements of existing conditions related to that portion of the Work, and observe conditions at the site.

C. Any errors, discrepancies, inconsistencies, or omissions discovered shall be promptly reported to the Architect as a request for Information.
   1. Contractor shall not proceed with the Work without written clarification from the Architect.

D. In the case of conflicts or discrepancies between Drawings and Specifications, or within either Document not clarified by Addendum, promptly submit written request to the Architect as a request for Information.
   1. Contractor shall not proceed with the Work without written clarification from the Architect.

E. Contractor shall request clarification in sufficient time to avoid delays and increases in the Contract Sum.

F. Contractor’s failure to report discrepancies or omissions in the Contract Documents, or Contractor- or Subcontractor-generated assumptions, in lieu of Architect-issued clarifications regarding the intent of the Contract Documents, shall not be used a basis for future claims once the apparent discrepancies or omissions have been reconciled by appropriate Information issued by the Architect.

1.4 REQUESTS FOR INFORMATION (RFIS)

A. Procedure: Immediately on discovery of the need for Information of the Contract Documents, and if not possible to request Information at Project meeting, prepare and submit an RFI in the form specified.
   1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor

will be returned 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 and the following:
   1. Project name
   2. Date
   3. Name of Contractor
   4. Name of Architect
   5. RFI number, numbered sequentially
   6. Specification Section number and title and related paragraphs, as appropriate
   7. Drawing number and detail references, as appropriate
   8. Field dimensions and existing conditions, as appropriate
   9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
   10. Contractor's signature
   11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing Information.
      a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.

C. Hard-Copy RFIs: CSI Form 13.2A included at end of this Section.
   1. Identify each page of attachments with the RFI number and sequential page number.

D. Software-Generated RFIs: Software-generated form with substantially the same content as indicated above.
   1. Attachments shall be electronic files in Adobe Acrobat PDF format.

E. Architect's Action: Architect and PD will review each RFI, determine action required, and return it. Allow three working days for Architect's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day. If more time or more information is needed, the RFI should be returned by the Architect within the 3 day period, stating such.
   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 Information of Architect's actions on submittals
      f. Incomplete RFIs or RFIs with numerous errors
   2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
   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.
   4. RFIs involving request for remedial action to correct nonconforming work, which are returned in more than fourteen working days, are not eligible for Contractor’s request for an increase in Contract Sum or an extension of Contract Time.

5. Where any action or response falls due on a Saturday, Sunday, or legal holiday, such action or response shall be considered due on the next business day which is not a Saturday, Sunday or a legal holiday.

F. 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 ten days if Contractor disagrees with response.

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 ATTACHMENTS

A. Refer to Section 01 26 13x for Request for Information, CSI Form 13.2A.

END OF SECTION

Advancement
of Constructio
Technology

REQUEST FOR INTERPRETATION

Project: _____ R.F.I. Number: _____

_____ From: _____

To: _____ Date: _____

_____ A/E Project Number: _____

Re: _____ Contract For: _____

Specification Section: Paragraph: Drawing Reference: Detail:

Request:

Signed by: Date:

Response:

☐ Attachments

Response From: To: Date Rec'd: Date Ret'd:

Signed by: Date:

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ File

01 31 00

PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General project coordination procedures.
   2. Coordination Drawings.
   3. Administrative and supervisory personnel.
   4. Conservation.
   5. Project meetings.

B. Related Sections include Division 01, Section “Requests for Information” for administrative procedures for handling RFIs.

1.2 COORDINATION

A. Coordination: Coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, which 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 with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.
   4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

B. If necessary, 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 and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to:
   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

D. Conservation: Coordinate construction activities to ensure that operations are carried out

with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Refer to Section 01 31 06.

B. Staff Names: Within 15 days of starting construction operations, submit a list of principal staff 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 and office telephone numbers. 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.

1.4 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

1.5 PROJECT MEETINGS

A. General: Contractor shall schedule and conduct weekly meetings with subcontractor's foremen and regular Project progress meetings/conferences with Project Manager and Architect 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 minimum of five business days prior to meeting date.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, Project Manager, and Architect, within three days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:
a. Tentative construction schedule
b. Phasing
c. Critical work sequencing
d. Designation of responsible personnel
e. Procedures for processing field decisions and Change Orders
f. Procedures for processing Applications for Payment
g. Distribution of the Contract Documents
h. Submittal procedures
i. Preparation of Record Documents

j. Use of the premises
k. Responsibility for temporary facilities and controls
l. Parking availability
m. Office, work, and storage areas
n. Equipment deliveries and priorities
o. First aid
p. Security
q. Progress cleaning
r. Working hours
s. Emerging Technologies and Procedures
t. Inspection required at Substantial Completion for Texas Department of Licensing and Regulations requirements for Texas Accessibility Standards compliance. Refer to Section 01 77 00.

C. Preinstallation Conferences: Conduct a preinstallation 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:
a. Contract Documents
b. Options
c. Related Change Orders
d. Submittals
e. Review of mockups
f. Possible conflicts
g. Compatibility problems
h. Time schedules
i. Weather limitations
j. Manufacturer's written recommendations
k. Warranty requirements
l. Compatibility of materials
m. Acceptability of substrates
n. Temporary facilities and controls
o. Space and access limitations
p. Regulations of authorities having jurisdiction
q. Testing and inspecting requirements
r. Required performance results
s. Protection of construction and personnel
3. Record significant conference discussions, agreements, and disagreements.
4. 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. Progress Meetings: Conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.
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 conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. 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.

b. Review present and future needs of each entity present, including the following:

1) Two week look ahead schedule
2) Interface requirements
3) Sequence of operations
4) Status of submittals
5) Deliveries
6) Off-site fabrication
7) Access
8) Site utilization
9) Temporary facilities and controls
10) Work hours
11) Progress cleaning
12) Status of correction of deficient items
13) Field observations
14) RFIs.
15) Status of proposal requests
16) Pending changes
17) Change Orders
18) Documentation of information for payment requests.

3. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.

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.

PART 2 PRODUCTS - Not applicable to this Section

PART 3 EXECUTION - Not applicable to this Section

END OF SECTION

01 32 00

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Preliminary Construction Schedule
   2. Contractor's Construction Schedule
   3. Submittals Schedule
   4. Daily construction reports
   5. Material location reports
   6. Field condition reports
   7. Special reports

B. Related Sections include the following:
   1. Division 01, Section "Payment Procedures" for submitting the Schedule of Values
   2. Division 01, Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes
   3. Division 01, Section "Submittal Procedures" for submitting schedules and reports
   4. Division 01, Section "Photographic Documentation" for submitting construction photographs

1.2 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 activities are activities on the critical path. They must start and finish on the planned early start and finish times.
   2. Predecessor activity is an activity that must be completed before a given activity can be started.

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 Project.

C. Critical Path: The longest continuous chain of 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 following activity.
   3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

F. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

G. Major Area: A story of construction, a separate building, a separate wing, a major department, or a similar significant construction element.

H. Milestone: A key or critical point in time for reference or measurement.

I. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

1.3 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.

B. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
   1. Scheduled date for first submittal
   2. Specification Section number and title
   3. Submittal category (action or informational)
   4. Name of subcontractor
   5. Description of the Work covered
   6. Scheduled date for Architect's final release or approval

C. Preliminary Construction Schedule: Submit two printed copies; one a single sheet of reproducible media, and one a print.

D. Contractor's Construction Schedule: Submit two printed copies of initial schedule, one a reproducible print and one a blue- or black-line print, large enough to show entire schedule for entire construction period.
   1. Submit an electronic copy of schedule, as required by owner. Include type of schedule (Initial or Updated) and date on label.

E. CPM Reports: Concurrent with CPM schedule, submit three printed copies of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float.
   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.

F. Daily Construction Reports: Submit two copies at weekly intervals.

G. Material Location Reports: Submit two copies at monthly intervals.

H. Field Condition Reports: Submit two copies at time of discovery of differing conditions.

I. Special Reports: Submit two copies at time of unusual event.

1.4 QUALITY ASSURANCE

A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:
1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including phasing, work stages, area separations, and interim milestones.
4. Review delivery dates for Owner-furnished products.
5. Review time required for review of submittals and resubmittals.
6. Review requirements for tests and inspections by independent testing and inspecting agencies.
7. Review time required for completion and startup procedures.
8. Review and finalize list of construction activities to be included in schedule.
9. Review submittal requirements and procedures.
10. Review procedures for updating schedule.

1.5 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, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
1. Secure time commitments for performing critical elements of the Work from parties involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 PRODUCTS

2.1 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule. Include submittals required during the first 60 days of construction. List those 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.
4. Submittals Schedule shall be submitted as one of the conditions precedent to the Architect releasing CAD files for Contractor’s use. Refer to Division 01 Section “Submittal Procedures” and Appendix ‘A’ – Electronic Drawing File Transfer Agreement Form, attached thereto.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Procedures: Comply with procedures contained in AGC's "Construction Planning &

Scheduling."

B. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.

C. Time Frame: Extend schedule from date established for commencement of the Work.
   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.

D. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
   1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
   2. Procurement Activities: Include procurement process activities for long lead items 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.
   3. 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 Submittals Schedule.
   4. Startup and Testing Time: Include not less than 14 days for startup and testing.
   5. 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.

E. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
   1. Work under More Than One Contract: Include a separate activity for each contract.
   2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
   3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary of Work." Delivery dates indicated stipulate the earliest possible delivery date. Indicate latest possible delivery date that will not affect critical path.
   4. 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. Use of premises restrictions
      e. Provisions for future construction
      f. Seasonal variations
      g. Environmental control
   5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
      a. Subcontract awards
      b. Submittals
      c. Purchases
      d. Mockups
      e. Fabrication
      f. Sample testing
      g. Deliveries
      h. Installation
      i. Tests and inspections
      j. Adjusting
      k. Curing

l. Minimum 90-day drying time of concrete floors prior to installation of floor finishes (Refer to Section 09 05 65)
m. Pre-installation moisture and alkalinity testing for non-breathable floor finishes (Refer to Section 09 05 65)
n. Startup and placement into final use and operation

6. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion
   b. Permanent space enclosure
   c. Completion of mechanical installation
   d. Completion of electrical installation
   e. Substantial Completion

F. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

G. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
   1. Refer to Division 01 Section "Payment Procedures" for cost reporting and payment procedures.

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

2.3 PRELIMINARY CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established for commencement of the work.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

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

B. CPM Schedule: Prepare Contractor's Construction Schedule using a CPM network analysis diagram.
   1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for commencement of the Work.
   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.

C. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary 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. Purchase of materials
   c. Delivery
   d. Fabrication
   e. Installation
2. Processing: Process data to produce output data or 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.
3. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
   a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

D. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. 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
9. Average size of workforce
10. Dollar value of activity (coordinated with the Schedule of Values)

E. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed
2. Changes in early and late start dates
3. Changes in early and late finish dates
4. Changes in activity durations in workdays
5. Changes in the critical path
6. Changes in total float or slack time
7. Changes in the Contract Time
8. Schedule early completion of areas in accordance with Phasing requirements. Refer to Section 01 11 00.

F. 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.

2.5 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. High and low temperatures and general weather conditions
   5. Accidents
   6. Meetings and significant decisions
   7. Unusual events (refer to special reports)
   8. Stoppages, delays, shortages, and losses
   9. Meter readings and similar recordings
   10. Emergency procedures
   11. Orders and requests of authorities having jurisdiction
   12. Change Orders received and implemented
   13. Construction Change Directives received
   14. Services connected and disconnected
   15. Equipment or system tests and startups
   16. Partial Completions and occupancies
   17. Substantial Completions authorized

B. Material Location Reports: At monthly intervals, prepare a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare a detailed report. Submit with a request for information in accordance with provisions of Section 01 26 13. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.6 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report electronically (as required by owner) 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. 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 including a two week “look ahead” 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 Actual Completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for the following:
   1. Preconstruction photographs.
   2. Periodic construction photographs.
   3. Final completion construction photographs.
   4. Demonstration and training video recordings.

B. Related Sections include the following:
   1. Division 01, Section "Submittal Procedures" for submitting photographic documentation.
   2. Division 01, Section "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.
   3. Division 01, Section "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
   4. Division 31, Section "Site Clearing" for photographic documentation before site clearing operations can commence.

1.2 INFORMATIONAL SUBMITTALS

A. FAA Requirements:
   1. Current FAA Certified Drone Pilot License according to 14 CFR 107, Subpart C – Remote Pilot Certification.
   2. Current FAA Registration if drone weighs more than 0.55 pounds

B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

C. Construction Photographs: Submit image files of each photographic view within three days of taking photographs.
   1. Digital Camera: Minimum sensor digital or high definition.
   2. Format: Minimum 1600 by 1200 pixels, 400 dpi minimum, in unaltered original files, with same aspect ratio as the sensor, uncropped, date- and time- stamped, in folder named by date of photograph, accompanied by key plan file.
   3. Identification: Provide the following information with each image description in file metadata tag:
      a. Name of Project
      b. Name and address of photographer
      c. Name of Architect
      d. Name of Contractor
      e. Date photograph was taken
      f. Description of vantage point, indicating location, direction (by

compass point), and elevation or story of construction
g. Unique sequential identifier keyed to accompanying key plan

D. Construction Photographs: Submit approved electronic media and photo views concurrent with Application for Payment.
1. Format shall be owner approved electronic media.
2. Identification: Provide the following information: properties of the submitted electronic media (example below).
a. Name of Project
b. Name of Architect
c. Name of Contractor
d. Date photograph was taken
e. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
f. Unique sequential identifier keyed to accompanying key plan.

E. Video Recordings: Submit two copies of each video recording within seven days of recording. Coordinate with Owner for all final media submissions.
1. Submit video recordings in digital video format acceptable to Owner.
2. Identification: For each copy (electronic or disc), provide the following information:
a. Name of Project
b. Name of Architect
c. Name of Contractor
d. Date video recording was made
e. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
f. Weather conditions at time of recording.

1.3 ON MONTHLY BASIS, PROVIDE AERIAL PHOTOS FROM TWO DIFFERENT VIEWS AND DELIVER TO LSCS.

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 without obscuring shadows.

1.4 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 6.0 megapixels, and at an image resolution of not less than 1600 by 1200 pixels.

B. Digital Video Recording Format: Provide high-resolution, digital video disc in format acceptable to Owner.
1. Recording quality shall be adequate to create photographic prints to be made from individual frames.

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 filename for each image.
   2. Field Office Images: Maintain one set of images in Owner approved media format in the field office at Project site, available at all times for reference. Identify images same as for those submitted to Architect.

C. Preconstruction Photographs: Before commencement of site clearing, excavation and demolition, take color print and digital photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
   1. Flag excavation areas and construction limits before taking construction photographs.
   2. Take twelve photographs to show existing conditions adjacent to property before starting the Work.
   3. Take twelve photographs 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 12 color print and digital photographs monthly, 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. Monthly UAV Drone Progressions:
   1. Comply with the safety requirements of 14 CFR 107. Include both panoramic and aerial video of the entire project captured monthly.
   2. Do not fly the drone higher than 400 feet.
   3. Photograph the 8 cardinal directions around the site perimeter and one top down, edited for proper exposure for allowing view of the entire site.
   4. Use the following personnel for all drone progressions:
      a. Remote Pilot in Command: Responsible for the operation of the small unmanned aircraft system.
      b. Visual Observer: Maintain unaided sight and position of small unmanned aircraft during flight.

F. Final Completion Construction Photographs: Take twelve color photographs after date of Substantial Completion for submission as Project Record Documents. Architect will direct photographer for desired vantage points.

G. Additional Photographs: Architect may issue requests for additional photographs, in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
   1. Three days notice will be given, where feasible.
   2. In emergency situations, take additional photographs within 24 hours of request.
   3. Circumstances that could require additional photographs include, but are not limited to, the following:

a. Special events planned at Project site.
b. Immediate follow-up when on-site events result in construction damage or losses.
c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
d. Substantial Completion of a major phase or component of the Work.
e. Extra record photographs at time of final acceptance.
f. Owner's request for special publicity photographs.

3.2 CONSTRUCTION VIDEO RECORDINGS

A. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.

B. Preconstruction Videotape: Before starting site clearing, excavation, and selective site demolition, record videotape of Project site and surrounding properties from different vantage points, as directed by Architect.
1. Flag excavation areas and construction limits before recording construction videotapes.
2. Show existing conditions adjacent to Project site before starting the Work.
3. Show existing buildings either on or adjoining Project site to accurately record physical conditions prior to the start of site clearing, excavation, and selective site demolition.
4. Show protection efforts by Contractor.

C. Periodic Construction Video Recordings: Record video recording monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last video recordings were recorded. Minimum recording time shall be a minimum of 30 minutes(s) to 24 hours.

END OF SECTION

01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information that requires Architect's responsive action.

B. Informational Submittals: Written information that does not require Architect's approval. Submittals may be rejected for not complying with requirements.

1.3 PROVISION AND USE OF ELECTRONIC FILES

A. General: Electronic CAD files of the Contract Drawings will NOT be furnished by Architect for Contractor's use in preparing submittals unless procedures stated within the attached Appendix A are agreed to by all parties and all parties sign the Agreement Form, and the Contractor properly prepares and submits the Submittals Schedule as indicated in Division 01, Section “Construction Progress Documentation.”

B. Release of electronic drawing files are conditional upon the following:
1. The drawings represented in the CAD files are not Contract Documents.
2. Files generally available for transfer will be limited to an impediments file as described in the Agreement.
3. Only one set of electronic drawing files will be furnished; Contractor assumes responsibility for distributing pertinent files to the various subcontractors.
4. The electronic drawing files have been developed without the assistance or specific expertise of the individual subcontractors and installers, and therefore do not account for or incorporate means, methods, shop standards, and routing economies required by individual subcontractors for the scope of work required by the finished Work.
5. Modifications to the information and routings of the selected components shown on the electronic drawing files may be required and are the responsibility of the Contractor. All modifications are part of the scope of Work of this Project and shall be provided at no additional cost to Owner.
6. Contractor and subcontractors agree that electronic drawing files are not fit for any particular purpose, including, but not limited to quantity take-offs, pricing, development of a building information model (BIM), clash detection, construction sequencing, or the manufacture of any building component or system.
7. There are no assurances that the electronic drawing files will be usable by the Contractor’s and subcontractors’ systems, infrastructure, or software; and that the files may be subject to anomalies, errors, viruses, malware, or other unintended defects.

C. Limitations of Electronic Drawing File Transfer Agreement:
1. Agreement Form applies to Architectural Drawings only. If Contractor desires electronic drawing files for Drawings prepared by one of Architect’s consultants, Contractor may contact consultant directly to obtain such files.
2. Contractor shall recognize that various consultants retained by the Architect for this

Project, or retained separately by the Owner, may have agreements that differ from that included in Appendix A, and may have differing costs and procedures involved with obtaining electronic drawing files.

3. Architect makes no assertion that the Architect's or Owner's consultants will furnish electronic files of their Drawings. Additionally, not all Drawings may be available electronically.

1.4 SUBMITTAL PROCEDURES

A. 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. 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.
      a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Submittals Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
   1. Contractor shall become familiar with submittal requirements specified in Division 01 and in each discipline's documents to develop a complete schedule of submittals as described in Division 01 Section 32 00.

C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal.
   1. Initial Review: Allow 15 calendar days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
   2. Concurrent Review: Where concurrent review of submittals by Architect's consultants, Owner, or other parties is required, allow 15 calendar days for initial review of each submittal.
   3. If intermediate submittal is necessary, process it in same manner as initial submittal.
   4. Allow 15 calendar days for processing each resubmittal.
   5. Unless otherwise indicated, where any action or submittal falls due on a Saturday, Sunday, or legal holiday, such action or submittal shall be considered due on the next business day which is not a Saturday, Sunday or a legal holiday.
   6. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.

D. Identification: Place a permanent label or title block on each submittal for identification.
   1. Indicate name of firm or entity that prepared each submittal on label or title block.
   2. Provide a space approximately 4 X 5 inches (100 by 125 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
   3. Include the following information on label for processing and recording action taken:
      a. Project name
      b. Date
      c. Name and address of Architect
      d. Name and address of Contractor
      e. Name and address of subcontractor
      f. Name and address of supplier

g. Name of manufacturer
h. Unique identifier, including revision number
i. Number and title of appropriate Specification Section
j. Drawing number and detail references, as appropriate
k. Other necessary identification.

E. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals. Provide accompanying detailed written explanation for deviation.

F. Additional Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.
1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.
2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.

G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using approved transmittal form which is attached. Architect will return submittals, without review received from sources other than Contractor.
1. 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 of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
3. Transmittal Form: Sample form included in Appendix C at end of Section. Final Submittal format to be approved by Owner.

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

I. Use for Construction: Use only final submittals with mark indicating “Approved” or “Approved as Noted” action taken by Architect in connection with construction.

PART 2 PRODUCTS

2.1 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual Specification Sections.
1. Number of Copies:
a. Submit four copies of each submittal, unless otherwise indicated. Architect will retain one copy and return three copies. Mark up and retain one returned copy as a Project Record Document. Copies shall be distributed as follows:
1) One copy for Contractor’s use.
2) One copy for subcontractor’s use.
3) One copy shall be provided to the Owner. Furnish Owner with final copy designated as “Approved” or “Approved as Noted” only.
4) Contractor shall be responsible for providing additional copies as required for additional personnel, field use, etc.
b. Submit one extra set of submittals to be retained by Architect’s consultant, where the consultant was delegated design responsibility for that item of work to which submittal pertains.

c. Submit one extra set of applicable Division 23 related submittals for Commissioning of HVAC system.

2. Surplus copies in addition to those indicated above will not be marked up by the Architect or consultant.

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 printed 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. Submittals not clearly identifying which products and options are being proposed will be returned without action.
3. Include the following information, as applicable:
   a. Manufacturer's written recommendations
   b. Manufacturer's product specifications
   c. Standard color charts
   d. Manufacturer's catalog cuts
   e. Wiring diagrams showing factory-installed wiring
   f. Compliance with recognized trade association standards
   g. Compliance with recognized testing agency standards
   h. Application of testing agency labels and seals
   i. Notation of coordination requirements

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. Submittals containing reproduction of Contract Drawings are not considered Shop Drawings and will be returned without action. Any delay due to such rejection will not be grounds for an extension of Contract Time.
2. Preparation: Include the following information, as applicable:
   a. Dimensions
   b. Identification of products
   c. Fabrication and installation drawings
   d. Roughing-in and setting diagrams
   e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring
   f. Templates and patterns
   g. Schedules
   h. Design calculations
   i. Compliance with specified standards
   j. Notation of coordination requirements
   k. Notation of dimensions established by field measurement
3. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
4. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches(215 by 280 mm) but no larger than 30 by 42 inches (750 by 1050 mm).
5. Number of Copies: Submit one correctable, translucent, reproducible print and three opaque prints of each submittal. Architect will return the marked-up reproducible print and two opaque prints for Contractor to make copies and distribute.

D. Samples: Prepare physical units of materials or products, including the following:

1. Comply with requirements in Division 01 Section "Quality Assurance Requirements" for mockups.
2. 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. Submit color charts showing actual colors (photographic representations or reproductions will not be accepted).

3. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the 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.
4. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Architect's sample where so indicated. Attach label on unexposed side that includes the following:
   a. Generic description of Sample
   b. Product name or name of manufacturer
   c. Sample source
5. Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, provide the following:
   a. Size limitations
   b. Compliance with recognized standards
   c. Availability
   d. Delivery time
6. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.
   a. If variation in color, pattern, texture, or other characteristic is inherent in the product represented by a Sample, submit at least three sets of paired units that show approximate limits of the variations.
   b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, and details of assembly, connections, operation, and similar construction characteristics.
7. Number of Samples for Initial Selection: Submit one full set 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.
8. Number of Samples for Verification: Submit three sets of Samples. Architect will retain two sample sets; remainder will be returned. Mark up and retain one returned Sample set as a Project Record Sample.
   a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
9. Coordinate with Architect for location of sample delivery to Architect’s office or to Project site.
10. 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 not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

E. Product Schedule or List: 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.
   2. Number and name of room or space.
   3. Location within room or space.

F. Submittals Schedule: Comply with requirements in Division 01, Section "Construction Progress Documentation."

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

H. Schedule of Values: Comply with requirements 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 (see attached Appendix B). 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.

2.2 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit Informational Submittals required by other Specification Sections.
   1. Number of Copies:
      a. Submit two copies of each submittal, unless otherwise indicated. Architect will not return copies.
      b. Submit one extra set of applicable Division 23 and other mechanical controls-related submittals for commissioning of HVAC System.
   2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification.
      a. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
   3. Test and Inspection Reports: Comply with requirements in Division 01 Section "Quality Assurance Requirements."

B. Coordination Drawings: Refer to Division 01 Section 31 06.

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

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

E. Certificates:
   1. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
   2. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.
   3. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.
   4. Product Certificates: Prepare written statements on manufacturer's letterhead

certifying that product complies with requirements.

5. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.

F. Test Reports:
1. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
2. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. 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.
3. Preconstruction Test Reports: Prepare 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.
4. Compatibility Test Reports: Prepare 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.
5. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, 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.

G. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 01 Section "Closeout Procedures."

H. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
1. Preparation of substrates
2. Required substrate tolerances
3. Sequence of installation or erection
4. Required installation tolerances
5. Required adjustments
6. Recommendations for cleaning and protection

I. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service 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.

J. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

K. Construction Photographs: Comply with requirements in Division 01 Section "Construction Progress Documentation."

L. Material Safety Data Sheets: Not a required submittal, nor subject to Architect's review or approval, since Contractor remains solely responsible for job site safety controls, procedures, and programs. Submit information directly to Owner as part of Closeout Submittals unless otherwise directed.
1. If submitted to Architect, Architect will not review this information and will return it with no action taken.

2.3 DELEGATED DESIGN

A. Design Data: Prepare 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.

B. 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.

C. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit three copies of a statement, 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. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
1. Ensure submittal is specifically required by the Contract Documents. Submittals not required shall not be submitted and will not be processed or reviewed by the Architect.
2. Verify:
   a. Field measurements
   b. Field construction criteria
   c. Catalog numbers and similar data
   d. Proper interface with adjacent or related work
3. Coordinate each submittal with requirements of Work of Contract Documents

4. Assign submittal number in accordance with the following:
   a. Six-digit Specification Section number
   b. Two-digit number representing product, material, or item in referenced Section to which submittal pertains (01, 02, 03, 04, etc.).
   c. Single letter representing submittal sequence ("A" for initial submittal, "B" for first re-submittal, "C" for second re-submittal, etc.).
5. Each specified material, product, or item shall be submitted individually, as a separate, uniquely identified submittal. Assembled booklets containing multiple products or systems will not be permitted, and will be returned without action.

B. 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.
   1. Language on Contractor's submittal review stamp shall be consistent with the requirements of the Agreement and General Conditions.
   2. A stamp containing language which defers or assigns Contractor's responsibilities to subcontractor will not be permitted; submittals bearing a stamp with such language will be returned without action. Any delay due to such rejection will not be grounds for an extension of Contract Time.

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 taken, as follows:
   1. Approved
   2. Approved as Noted
   3. Revise and Resubmit
   4. Not Approved
   5. No Action Required by Architect

C. Informational Submittals: Architect will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

E. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION

01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 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, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.2 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. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
2. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance

with specified criteria.

E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
   1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

1.3 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.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. 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.

1.6 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
1. Project quality-control manager 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: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.

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.

1.7 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.

4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and 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.

1.8 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

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

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
   1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
   2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

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

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

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
   1. Contractor responsibilities include the following:
      a. Provide test specimens representative of proposed products and construction.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
      c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
      d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
      e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
      f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory 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 and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

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

L. Integrated Exterior Mockups: Refer to Section 01 43 39 “Mockups” for requirements.

M. Room Mockups: Refer to Section 01 43 39 “Mockups” for requirements.

N. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections.

1.9 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. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
   3. 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.

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

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 “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. Retesting/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.

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

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

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

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
   1. Date test or inspection was conducted.
   2. Description of the Work tested or inspected.
   3. Date test or inspection results were transmitted to Architect.
   4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority'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

SECTION 01 40 00 QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mock-ups.
B. Control of installation.
C. Tolerances.
D. Testing and inspection services.
E. Manufacturers' field services.

1.02 RELATED REQUIREMENTS

A. Document 00 31 00 - Available Project Information: Soil investigation data.
B. Document 00 72 00 - General Conditions: Inspections and approvals required by public authorities.
C. Section 01 30 00 - Administrative Requirements: Submittal procedures.
D. Section 01 42 19 - Reference Standards.
E. Section 01 60 00 - Product Requirements: Requirements for material and product quality.

1.03 REFERENCE STANDARDS

A. ASTM C 1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants; 2008.
B. ASTM C 1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation; 2009.
C. ASTM D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction; 2008.
D. ASTM E 543 - Standard Specification for Agencies Performing Nondestructive Testing; 2009.

1.04 SUBMITTALS

A. Testing Agency Qualifications:
   1. Prior to start of Work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
B. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents, or for Owner's information.
C. Test Reports: After each test/inspection, promptly submit two copies of report to Architect and to Contractor.
   1. Include:
   2. Test report submittals are for Architect's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents, or for Owner's information.
D. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in

quantities specified for Product Data.

1. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect.

E. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.05 REFERENCES AND STANDARDS - See Section 01 42 19

1.06 TESTING AND INSPECTION AGENCIES

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

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

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

3.02 MOCK-UPS

A. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.
B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
C. Accepted mock-ups shall be a comparison standard for the remaining Work.
D. Where mock-up has been accepted by Architect and is specified in product specification

sections to be removed, remove mock-up and clear area when directed to do so.

3.03 TOLERANCES

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

3.04 TESTING AND INSPECTION

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

Contractor.

G. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect. Payment for re testing will be charged to the Contractor by deducting testing charges from the Contract Price.

3.05 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.06 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not conforming to specified requirements.

B. If, in the opinion of Architect, it is not practical to remove and replace the Work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION

SECTION 01 45 23 - TESTING AND INSPECTING SERVICES

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 and qualifications including but not limited to:
   1. Professional testing and laboratory services.
   2. Accessories necessary for the completion of testing and laboratory services.

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 quality 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 quality control procedures that facilitate compliance with Contract Document requirements.
   3. Requirements for Contractor to provide quality assurance and quality control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions.
   4. Specific test and inspection requirements are not specified in this Section.

C. A qualified independent testing laboratory and/or geotechnical engineering service selected and paid by Owner.
   1. The Owner will pay for the initial laboratory services of materials that comply with the requirements of the Contract Documents. The Contractor shall pay for testing and retesting of materials that do not comply with the requirements of the Contract Documents.

D. Inspecting agency shall perform inspections and tests in accordance with the rules and regulations of the building code, local authorities, Specifications of ASTM, and the Contract Documents.

E. Materials and workmanship found not in compliance with required standards or performance obligations shall be removed and replaced. Replacement and subsequent testing shall be at Contractor’s expense.

F. Where terms “Inspector” and “Laboratory” are used, it is meant and in reference to an officially designated and accredited inspector of the testing laboratory or geotechnical service engaged by Owner.

G. Laboratory inspections shall not relieve the Contractor or Fabricator of his responsibility to furnish materials and workmanship in accordance with the Contract Documents.

H. Contractor or Fabricator shall cooperate with the testing laboratory in matters pertaining to the Work.

I. Contractor to address deficiency and failed reports.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, documented according to ASTM E 329 and ASTM E534; 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.
   3. Testing agencies shall be insured against errors and omissions by a professional liability insurance policy having a minimum limit of liability of $500,000.00.

B. Inspection and testing services the of testing agency shall be under the direction of a Registered Engineer licensed in the State of Texas, charged with engineering managerial responsibility, and having a minimum of five (5) years engineering experience in inspection and testing of construction materials.

C. Concrete Inspectors: Inspecting personnel monitoring concrete Work shall be ACI certified inspectors.

D. Structural Steel: Primary inspectors performing structural steel inspection shall be currently certified AWS Certified Welding Inspectors (CWI), in accordance with the provisions of AWS QCI, *Standard and Guide for Qualification and Certification of Welding Inspectors*.
   1. Inspector may be supported by assistant inspectors who perform specific inspection functions under the direct supervision of the Primary Inspector. Assistant inspectors shall be currently certified AWS Certified Associate Welding Inspectors (CAWI). Work of assistant inspectors shall be monitored daily by the inspector.

E. Testing Equipment: Equipment shall be calibrated at intervals not exceeding 12 months by devices of accuracy traceable to the National Bureau of Standards.

F. Referenced Standards: Latest adopted edition of standards referenced apply to the Work. In the event of conflict between the Contract Documents and referenced standards, the Contract Documents shall govern. In case of conflict between Contract Documents and the Building Code, the more stringent shall govern.

1.4 QUALITY CONTROL

A. Owner Responsibilities: Where quality control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform the services.
   1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
   2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, 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. Refer to the individual specification sections for specific requirements.

2. 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.
3. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform the quality control services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
4. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
5. Where quality control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality control service.
6. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
7. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
8. Associated Responsibilities and 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:
    a. Provide access to the Work.
    b. Deliver of samples to testing laboratory, without cost to Owner, in adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
    c. Advise laboratory and Architect sufficiently in advance of construction operations to allow laboratory to complete required inspections or tests and to assign personnel for field inspection and testing as specified.
    d. Provide facilities for storage and curing of concrete test samples on site for the first 24 hours and for subsequent field curing required by ASTM C31.
    e. Incidental labor, facilities, and equipment necessary to assist laboratory personnel in obtaining and handling samples at the site.
    f. Preliminary design mix proposed for use for material mixes that require control by testing agency.
    g. Provide concrete mix designs in accordance with ACI 301 Section 3.9 made by an independent testing laboratory or qualified concrete supplier. Where mix designs by an independent testing laboratory are required, select and pay for laboratory.
    h. Obtain required inspections or approvals of the building official. Inspection requests and notifications required by building code are responsibility of the Contractor.
    i. Provide current welder certificates for each welder employed.
    j. Provide fabrication and erection inspection and testing of welds in accordance with AWS D1.1, Chapter 6.
        1) Use prequalification of welding procedures in executing the Work.
    k. Security and protection for samples and for testing and inspecting equipment at Project site.
9. Retesting/Reinspecting: Regardless of payment responsibility of the original tests or inspections, provide quality control services, including retesting and reinspecting, for construction that replaced Work failing to comply with the Contract Documents or Code requirements.

C. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.

4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

D. Coordination: Coordinate sequence of activities to accommodate required quality assurance and quality 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.

1.5 AUTHORITY AND DUTIES OF LABORATORY PERSONNEL

A. A representative of the testing laboratory, who has reviewed and is familiar with the project and specifications, shall participate in preconstruction conferences. The representative shall coordinate material testing and inspection requirements with the Contractor and its subcontractors consistent with the planned construction schedule. The laboratory representative shall attend conferences required or requested to address quality control issues.

B. Laboratory personnel shall inspect and test materials, assemblies, specimens, and Work performed, including design mixes, methods and techniques and report the progress to the Architect.

C. If material or Work fails to meet requirements of Contract Documents, laboratory inspector shall notify the Construction Manager, Architect, Engineers, supplier or subcontractor providing or preparing the materials or Work being tested of such failure.

D. Laboratory personnel shall not perform the Work of the Contractor or act as foremen or superintendents. Work will be inspected as it progresses, but failure to detect defective Work or materials shall not prevent later rejection when a defect is discovered.

E. Laboratory personnel are not authorized to revoke, alter, relax, enlarge, or release the requirements of the Contract Documents or approve or accept portions of Work, except where approval is specifically specified in the Specifications.

F. Comply with building code requirements for Special Inspections.

1.6 SUBMITTALS

A. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

B. 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.

C. Test and Inspection Reports: Prepare and submit certified written reports specified. Include the following:
   1. Date of issue.
   2. Project title and number.
   3. Name, address, and telephone number of testing agency.
   4. Dates and locations of samples and tests or inspections.
   5. Names of individuals making tests and inspections.
   6. Description of the Work and test and inspection method.
   7. Identification of product and Specification Section.
   8. Complete test or inspection data.
   9. Test and inspection results and an interpretation of test results.
   10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
   11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
   12. Name and signature of laboratory inspector.
   13. Recommendations on retesting and reinspecting.

D. Submit copies of reports of each inspection and test:
   1. Owner, Program or Project Manager, Architect, and each Engineer or outside consultants regarding their particular phase of the project: One copy each.
   2. Construction Manager and Contractor: Two copies each.

E. In addition to furnishing a written report, notify Construction Manager and Contractor verbally of uncorrected conditions or failures to comply with requirements of the Contract Documents, and immediately fax and email corresponding report to the Architect and Engineer.

F. At completion of each trade or branch of Work requiring inspecting and testing, submit a final certificate attesting to satisfactory completion of Work and full compliance with requirements of Contract Documents.

G. Submit copies of test results sealed by a Registered Engineer to municipal authorities having jurisdiction, as required.

1.7 TESTING LABORATORY GUIDELINES AND PROCEDURES

A. Technicians scheduled to perform specific testing services must be qualified to review and perform other services that overlap, i.e. earthwork, foundation inspections, rebar inspection, and concrete when scheduled concurrently at the site.

B. Technician time for services performed will be reimbursed at a regular time rate. Compensation at the overtime rate will be considered for hours over eight hours spent at the site on a single day, field testing services performed on a Saturday or Sunday, and field services performed on a recognized holiday.

C. There shall be a three hour minimum for each scheduled testing service. Vehicle charges will be included on a $25.00 per trip basis.

D. Cylinder pick up will be controlled by the technician performing test on a scheduled pick up day. If there are no testing services scheduled, the cylinder pick up fee is $40.00 on week days and $50.00 on weekends and holidays with no technician or vehicle charge.

E. The Contractor shall bear the responsibility of scheduling the testing services. The Contractor and the testing laboratory shall assume full responsibility to coordinate the testing services.

Cancellations or failed test shall be reimbursable to the Owner by the responsible party for the cancellations or failure of a test or service.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
   1. Date test or inspection was conducted.
   2. Description of the Work tested or inspected.
   3. Date test or inspection results were transmitted to Architect.
   4. Identification of testing agency or special inspector conducting test or inspection.
   5. Deficiency log.

B. Maintain log at site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 TESTING AND INSPECTION SERVICES

A. Testing services shall include, but not be limited to those specified below or which are necessary or required during course of construction to ascertain specification compliance and which may be deemed necessary by Architect, Engineer, or Owner to ensure the quality of the Work.

B. The Owner reserves the right to add to or delete any or all inspection and testing specified, excluding testing required by the applicable building codes.

C. If conflicts arise between Drawings and Specifications, notify Architect immediately. The most stringent requirements shall dictate procedure.

3.3 TESTING OF EARTHWORK

A. Testing Services (As specified or required):
   1. References (As applicable for tests required):
      a. American Society for Testing and Materials (ASTM)
         1) D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)
         2) D2922, Standard Test Method for Density of Soil and Soil-Aggregate In Place By Nuclear Methods (Shallow Depth)
         3) D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
      b. American Association of State Highway and Transportation Officials (AASHTO)
         1) T89, Determining the Liquid Limit of Soils
         2) T90, Determining the Plastic Limit and Plasticity Index of Soils
         3) T99, Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305-mm (12-in) Drop
         4) T238, Density of Soil and Soil Aggregates In Place By Nuclear Methods (Shallow Depth)
   2. Perform sieve analysis to develop grain size distribution curves for materials to be used for subgrade, fill under slab on grade, and backfills.
   3. Establish the moisture density relation of soils to be used as fill using the method best suited to the type of fill material.

4. Determine moisture content of all fill materials before placement and advise Contractor when it is or is not suitable to achieve required compaction.
5. Determine Liquid Limit in accordance with ASTM D4318 or AASHTO T89, Plastic Limit in accordance with ASTM D4318, and Plasticity Index in accordance with ASTM D4318 of all fill material,
6. Perform one in place density test for each 2,500 square feet (280 square yards) of existing subgrade material.
7. Perform Moisture-Density curve in accordance with ASTM D698 or AASHTO T99 for one type of fill material. If the original choice of material does not meet the specifications, the Contractor shall pay for additional testing.
8. Perform in place density tests of each lift of compacted fill at locations adequate to evaluate the degree of compaction of all fill areas. Conduct one test for each 2,500 square feet (280 square yards) of each lift of compacted fill.
9. Perform testing at a frequency of one in-place density and moisture test for each 75 lineal feet or less of utility trench, with a minimum of three tests per lift

B. Reports: Submit reports with the following information:
1. Type and condition of soil at footing bottoms.
2. Level of water table in the excavated areas.
3. Grain size distribution of fill materials (average of three tests).
4. Moisture density test results.
5. In place density test results with moisture content and relative density of each layer of compacted fill. Include with in place density test results, a plan showing location of each test.
6. Notify Architect by telephone within one hour of the discovery of the following conditions and follow up telephone notification with written report.
   a. Materials used, or degree of soil compaction not meeting specified requirements.
   b. Frost and freeze protection requirements for excavation bottoms not being complied with.
   c. Water in excavations which is not being removed prior to Work being performed in excavation.

3.4 INSPECTION OF PIPED SITE UTILITIES

A. Laboratory representative shall observe and report on the following:
1. Proper alignment and grade of trenches.
2. Pipe bedding and supports.
3. Pipe, joints, jointing material, and thrust blocks prior to installation of pipe.
4. Installation of pipe and joints.
5. Testing of piped utilities performed by Contractor.

3.5 PAVING

A. Testing Services: Perform field tests for moisture density properties:
1. Provide field testing of the subgrade as specified.
2. Paving Subbase: Provide one field test for every 5,000 square feet of area of crushed limestone or caliche subbase.
3. Lime Treated Subgrade: Provide one field test for every 5,000 square feet of area of lime treated subgrade for content of lime and subgrade compaction.
4. Cement Soil Stabilization: Provide one field test for every 5,000 square feet of area of cement stabilized subgrade for content of cement and subgrade compaction.

3.6 PIER DRILLING OPERATION

A. A representative of a qualified geotechnical laboratory shall provide services specified.

B. Laboratory representative shall make continuous inspections to determine that proper bearing stratum is obtained and utilized for bearing and that shafts are properly clean and dry before placing concrete.

C. Laboratory shall furnish complete pier log showing the diameter, top and bottom elevations of each pier, casing required or not required, actual penetration into bearing stratum, elevation of top of bearing stratum, volume of concrete used, and deviations from specified tolerances.

D. Laboratory representative shall make continuous inspections of drilled pier construction to check the following:
   1. Verify soundness of bearing stratum and desired penetration.
   2. Verify pier dimensions and reinforcing used.
   3. Monitor condition of hole and removal of water and loose material from bottom.
   4. Monitor placement of concrete and use of tremie or pumps.
   5. Monitor the extraction of casing, if used.

E. Request probe holes when deemed necessary to confirm safe bearing capacity.

3.7 CONCRETE REINFORCING STEEL AND EMBEDDED METAL ASSEMBLIES

A. Inspect concrete reinforcing steel prior to placing concrete for compliance with Contract Documents and approved shop drawings. Noncompliance with Contract Documents and approved shop drawings shall be immediately brought to the attention of the Contractor for correction and, if left uncorrected, reported to the Architect.

B. Laboratory representative shall observe and report on the following:
   1. Number and size of bars.
   2. Bending and lengths of bars.
   3. Splicing.
   4. Clearance to forms, including chair heights.
   5. Clearance to sides and bottom of trench if soil formed.
   6. Clearance between bars or spacing.
   7. Rust, form oil, and other contamination.
   8. Grade of steel.
   9. Securing, tying, and chairing of bars.
   10. Excessive congestion of reinforcing steel.
   11. Installation of anchor bolts and placement of concrete around such bolts.
   12. Fabrication and installation of embedded metal assemblies, including visual inspection of all welds.
   13. Visually inspect studs and deformed bar anchors on embedded assemblies for compliance with Contract Documents. Check number, spacing and weld quality. If, after welding, visual inspection reveals that a sound weld or a full 360 degree fillet has not been obtained for a particular stud or bar, such stud or bar shall be struck with a hammer and bent 15 degrees off perpendicular and then bent back into position. Anchors failing this test shall be replaced.

C. Provide a qualified, experienced inspector to inspect reinforcing steel. Inspector shall have a minimum of three years experience inspecting reinforcing steel in projects of similar size.

3.8 CONCRETE INSPECTION AND TESTING

A. Receive and evaluate proposed concrete mix designs submitted by Contractor. If mix designs comply with Drawings and Specifications, the laboratory shall submit a letter to the Architect certifying compliance. Mix designs not complying with Drawings and Specifications shall be

returned by the laboratory as being unacceptable. Check the proposed mixes for proportions, water cement ratio and slump in accordance with ACI 613 and 318.

B. Comply with ACI 311 *Guide For Concrete Inspection* and ACI *Manual of Concrete Inspection* (SP-2).

C. Sample and test concrete placed at the site in accordance with ASTM C172. Each sample shall be obtained from a different batch of concrete on a random basis.

D. Test concrete:
   1. Mold and cure five specimens from each sample.
      a. For each 50 cubic yards or fraction thereof of structural building concrete; and
      b. For each 100 cubic yards or fraction thereof of nonstructural concrete and site Work paving and sidewalks.
      c. Laboratory cure two cylinders in accordance with ASTM C192.
      d. Field cure remaining cylinders in accordance with ASTM C31.
   2. Two specimens shall be tested at seven days for information, two shall be tested at 28 days for acceptance.
   3. Store one cylinder for testing at 56 days in the event the 28 days strength tests do not meet strength requirements.

E. Deviations from the requirements of ASTM Specifications shall be recorded in the test report. Test concrete specimens in accordance with ASTM C39.

F. Specimens for pumped concrete shall be taken at the discharge end of pumping equipment.

G. Supervise curing and protection provided for test specimens in field, and transportation from the field to laboratory. Test cylinders shall be stored in the field 24 hours and then carefully transported to laboratory and cured in accordance with ASTM C31.

H. Make one strength test (four cylinders) of each mix design of concrete placed in any one day.

I. Make one slump test for each set of cylinders following procedural requirements of ASTM C143 and ASTM C172. Make additional slump tests whenever consistency of concrete appears to vary. Slump tests corresponding to samples from which strength tests are made shall be reported with strength test results. Other slump tests need not be reported.

J. Determine total air content of air entrained normal weight concrete sample for each strength test in accordance with ASTM C231.

K. Determine air content and unit weight of lightweight concrete sample for each strength test in accordance with ASTM C173 and ASTM C567.

L. Determine temperature of concrete sample for each strength test.

M. Inspect each batch of concrete, monitor addition of mixing water to assure uniform consistency from truck to truck. Check mixing form mixers before mix begins to set and within time limits set forth in ASTM C94.
   1. Monitor addition of water and high range water reducer to concrete at job site and length of time concrete is allowed to remain in truck during placement.

N. Testing agency shall furnish and maintain a competent inspector at the mixing plant at the start of each day's mixing. Inspector shall examine concrete materials for compliance with Specifications and approved mix design, weighing and measuring devices, proportioning and mixing of materials, water and cement content of each batch, general operation of the plant, and

transportation of concrete to jobsite. Inspector shall verify that amount of free surface moisture contained in fine and course aggregate has been properly accounted for in the concrete mixing to achieve required consistency and water cement ratio.

O. Testing laboratory shall monitor addition of water to concrete at the jobsite and the length of time concrete is allowed to remain in the truck before placement. Inspector shall compare mixture with criteria on the approved mix design and report any significant deviation to the Architect, Contractor and concrete supplier. Do not permit addition of water which will exceed maximum water/cement ratio for the mix as given on the approved mix design.

P. Observe placing of concrete, except nonstructural slabs on grade and site Work. Observe and report on placing method, consolidation, cold joints, length of drop, and displacement of reinforcement. Report deficiencies to Contractor immediately for corrective action. Inspections may be reduced to a periodic basis when all procedures have been deemed satisfactory by the laboratory.

Q. Test reports shall include but no be limited to the following information: date of concrete placement, concrete mix identification number or proportion of ingredients, truck ticket number, time test was made, time of batching, location of each placement, slump, unit weight, water content (microwave test) and air content of concrete sampled and date and results of strength test.

R. Report promptly to Architect all details of reasons for rejection of any and all quantities of concrete. Give all information concerning locations of the concrete pours, quantities, date of pours, and other pertinent facts concerning concrete represented by the specimens.

S. Testing laboratory shall certify each delivery ticket indicating class of concrete delivered (or placed), amount of water added and time at which cement and aggregate were dispensed into the truck, and time at which concrete was discharged from the truck.

T. Evaluation and Acceptance:
   1. If measured slump, or air content of air entrained concrete, falls outside specified limits, a check test shall be made immediately on another portion of the same sample. In the event of a second failure, concrete shall be considered to have failed to meet the requirements of the specifications, and shall not be used in the structure.
   2. Strength level of concrete will be considered satisfactory if the averages of sets of three consecutive strength tests results are equal to, or exceed, specified strength and no individual test result (average of two cylinders) is below specified strength by more than 500 psi.
   3. Completed concrete Work will be accepted when requirements of ACI 301 Chapter 18 *Specifications for Structural Concrete for Buildings* have been met.

U. Concrete Test Reports: Reports shall be made and distributed immediately after respective tests or inspections are made.
   1. Where reports indicate deviations from Contract Documents, they shall also include a determination of the probable cause of deviation and where applicable, a recommendation for corrective action.

V. Furnish a statistical analysis for each class of concrete placed on the project in accordance with ACI 214 and ACI 318. Information shall be updated and distributed once a month as directed by the Architect. Information shall include, but not be limited to, the following:
   1. Strength tests at seven days.
   2. Strength tests at 28 days of two cylinder averages.
   3. 28 day moving average strength tests of last three test groups.
   4. Standard deviation and coefficient of variation based on 28 day strength tests.
   5. Average strength and number of 28 days tests for most recent month.

6. Strength test one cylinder at 56 days in the event the 28 days strength tests do not meet strength requirements.

W. Test Footings (Shafts) (Piers) (Caissons): Same diameter and type specified for footings, placed in same manner. Accepted test footings may be used in the Work.

X. Noncompliant Test Reports: Fax test reports indicating noncompliance immediately to each party on the test report distribution list. Copies shall be on different colored paper.

Y. Inspect application of curing compound and monitor curing conditions to assure compliance with specification requirements. Report curing deficiencies to the Contractor immediately and submit a written report to the Architect.

3.9 TESTING OF NONSHRINK GROUT

A. Make one strength test for all plates grouted and for all grout used in joints between members.

B. Each test shall consist of four cubes, two tested at 7 days and two at 28 days, made and tested in accordance with ASTM C109, with the exception that grout shall be restrained from expansion by a top plate.

3.10 STRUCTURAL STEEL

A. Inspect structural steel during and after erection for compliance with Contract Documents and shop drawings. Review and report on fabricator's quality control procedures and capabilities.

B. Field Inspection:
1. Proper erection of pieces.
2. Proper touch up painting of shop primed structural steel exposed to view or in crawl space.
3. Proper installation of bolts.
4. Plumbness of structure and proper bracing.
5. Proper field painting.
6. Initial inspection of welding process and periodically thereafter as necessary.
7. Visual examination of completed welds.
8. Ultrasonic testing of penetration field welds.
9. Installation of field welded shear studs.
10. Inspect shop fabricated members, upon arrival at the site, for defects incurred during transit and handling.
11. Measure and record camber of beams upon arrival and before erection for compliance with specified camber. Measure lying flat with web horizontal. Return members outside specified camber tolerance to shop for correction.

C. Qualifications of Welders: Fabricator and erector shall provide the testing laboratory with names of welders employed on Work, along with certification that each welder has passed qualification tests within the past 12 months, using procedures covered in AWS D1.1 *Structural Welding Code - Steel*. Verify welder qualifications.

D. Inspection of field welding shall include:
1. Visually inspect fillet welds for size, soundness, and proper return around ends. Inspect seams, folds, and delaminations.
2. Visually inspect welds for proper repair of painting.
3. Ultrasonically test penetration welds in accordance with ASTM E164.
4. Inspect surfaces to be welded. Note surface preparations, fit up, and cleanliness of surface. Verify electrodes for size, type, and condition.

5. Welding inspector shall be present during alignment and fit up of members being welded, and shall verify for correct surface preparation of root openings, sound weld metal, and proper penetration in the root pass. Where weld has not penetrated completely, inspector shall order the joint to be chipped down to sound metal, or gouged out, and rewelded. Thoroughly inspect root passes for cracks. Gouge out cracks and rewelded to 2 inches beyond each end of crack.
6. Inspector shall verify that welds have been marked with welder's symbol and shall mark welds requiring repairs and reinspection. Inspector shall maintain a written record of welds. Work completed and inspected shall receive an identification mark by the inspector. Identify unacceptable material and Work identified by word *reject* or *repair* marked directly on the material.
7. Testing agency shall advise the Owner and Architect of any shop and/or field conditions which may require further tests and examination by means other than those specified. Additional tests and examinations shall be performed as authorized by the Owner and Architect.
8. Owner reserves the right to use ultrasonic or radiographic inspection to verify adequacy of welds. Testing procedures and acceptance criteria shall be as specified in AWS D1.1.
9. Weld quality to comply with the American Institute of Steel Construction (AISC) Manual of Steel Construction.
10. Determine percentage of weld tested by the number of welds that fail the initial testing.
11. Reweld and retest welds that fail until the welds pass. Test two additional welds for every weld failure.

E. Inspect bolted construction in accordance with AISC *Specification for Structural Steel Buildings*:
1. Visually inspect bolts ensuring that plies have been brought into snug contact.
2. Inspect high strength bolt in accordance with Section 9 of the *Specifications for Structural Joints Using ASTM A325 or A490 Bolts*.

F. Inspect stud welding in accordance with Section 7.8, of AWS D1.1 *Structural Welding Code*:
1. Weld at least two shear studs at the start of each production period to determine correct generator, control unit, and stud welder setting. The studs shall be capable of being bent 45 degrees from vertical without weld failure.
2. When the temperature is below 32 degrees F (0 degrees C), test one stud in each 100 after cooling. Do not weld studs at temperatures below 0 degrees F or when surface is wet with rain or snow. If stud fails in the weld, two new studs shall pass the test before resumption of welding.
3. Visually inspect studs for compliance with the requirements of the Contract Documents. Verify number, spacing, and weld quality. If, after welding, visual inspection reveals that a sound weld or a full 360 degree fillet has not been obtained for a particular stud, that stud shall be struck with a hammer and bent 15 degrees off perpendicular in the direction away from the missing weld. Studs failing test shall be replaced.

3.11 REINFORCING STEEL MECHANICAL SPLICES

A. Inspection and Observation Services:
1. Visually inspect and report on completed condition of each mechanical splice of reinforcing steel.
2. Visually inspect each mechanical splice to ensure compliance with the ICC-ES Reports and the manufacturer's published criteria for acceptable completed splices.
3. Place special emphasis on the inspection of the end preparation of each bar to be spliced required by the ICC-ES Report.

B. Reports: Submit reports to Architect:
1. Submit copies of manufacturer's published criteria for acceptable completed splices prior to observing mechanical splices.

2. Reports on each mechanical splice shall indicate location of the splice, size of bars spliced, and acceptability or rejection of splice. Indicate reasons for rejection on each report.

3.12 OPEN WEB JOISTS AND JOIST GIRDERS

A. Inspect joists at jobsite for compliance with specified fabrication requirements. Verify welded connections between web and chord, splices, and straightness of members.

B. Inspect installation of joists at jobsite. Check connections to supporting members, chord extensions, number of rows of bridging, and bridging connections for compliance with Contract Documents and referenced standards.

C. Verify welder qualification certificates for both shop and field welding operators.

3.13 METAL FLOOR DECK

A. Field inspection shall consist of:
   1. Verifying types, gauges and finishes for compliance with Contract Documents and shop drawings.
   2. Examine composite floor deck exposed to crawl space for damage to galvanizing due to welding or construction activities. Repair galvanized composite floor deck in accordance with the specifications.
   3. Examine the erection of metal deck, fastenings, reinforcing of holes, deck reinforcing, miscellaneous deck supports, hanger tabs, shear studs, deck closures, painting or other coating.
   4. Certification of welders.
   5. Inspect and test field welded shear studs used to fasten metal floor decking to supporting steel as specified for structural steel.

3.14 METAL ROOF DECK

A. Field inspection shall consist of:
   1. Verify types, gauges and finishes for compliance with Contract Documents and shop drawings.
   2. Examine the erection of the metal deck, including fastenings at supports and side laps, reinforcing of holes, and miscellaneous deck supports.
   3. Certification of welders.
   4. Visual inspection of at least 25 percent of welds.

3.15 SPRAYED FIREPROOFING

A. Verify applied thickness, density, and bond strength of sprayed fireproofing meets fire rating requirements of approved design.

B. Verify installation complies with fire rating requirements of approved design.

C. Inspect and test for thickness:
   1. Test 25 percent of structural frame columns and beams in each building level.
   2. Test 10 percent of beams other than structural frame in each building level.
   3. Test one slab per 5,000 square feet of building area.

D. Inspect and test in accordance procedures of ASTM E605 and ASTM E736.

3.16 EXPANSION BOLT INSTALLATION

A. Inspect drilling of each hole and installation of each expansion bolt for compliance with Contract Documents and shop drawings.

B. Verify installation torque for each expansion bolt for compliance with manufacturer's installation instructions.

3.17 LIGHTWEIGHT INSULATING CONCRETE FILL

A. Inspection and Observation Services (As required):
   1. Inspection of roof deck prior to start of Work.
   2. Inspection during installation of insulation and lightweight insulating concrete fill Work to ascertain compliance with Contract Documents.
   3. Observation of base ply fastener pull tests performed by Contractor to ascertain minimum withdrawal resistance of 40 pounds per fastener.

B. Testing Services (As required):
   1. References (As applicable for tests required):
      a. American Society for Testing and Materials (ASTM)
         1) C177, Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties By Means of the Guarded Hot Plate Apparatus
         2) C495, Test Method for Compressive Strength of Lightweight Insulating Concrete
         3) C578, Specification for Rigid, Cellular Polystyrene Thermal Insulation
   2. Test EPS insulation board for thermal insulation value in accordance with ASTM C177.
   3. Test lightweight insulating concrete fill in accordance with ASTM C495 for:
      a. Mix design compressive strength.
      b. Mix design wet and dry density range.
      c. Number of Tests:
         1) One per 5,000 square feet
         2) Not less than one for each day's Work
   4. Test EPS insulation board for density in accordance with ASTM C578.

3.18 TESTING OF ROOFING

A. Inspection and Observation Services (As required):
   1. Inspection of roof deck prior to start of Work.
   2. Inspect on site condition of stored roofing materials.
   3. Inspection during roofing, roof insulation, and sheet metal Work to ascertain compliance with Contract Documents.
   4. Observation of roof test cuts performed by Contractor to ascertain that they are properly made.
   5. Observation of patching of roof test cuts to ascertain that they are properly made.

B. Testing Services (As required):
   1. Perform dissection and analysis on cuts provided by Contractor to confirm number of plies, bonding of plies, weight of bitumen and softening temperature to ascertain compliance with specifications.

3.19 MASONRY

A. Inspection and Observation Services:
   1. Inspection of placement of reinforcement including condition, grade, size, location, spacing, and lap splices.
   2. Review mortar design mixes.
   3. Inspection of laying, mortaring, and grouting of concrete masonry units and elements.

B. Testing Services:
   1. References (As applicable for tests required):
      a. ASTM International (ASTM)
         1) C140, Standard Test Methods of Sampling and Testing Concrete Masonry Units
         2) C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
         3) C1019, Standard Test Method for Sampling and Testing Grout
         4) E447-97, Standard Test Methods for Compressive Strength of Laboratory Constructed Masonry Prisms
   2. Testing of Concrete Masonry Units (CMU):
      a. Preconstruction: Perform the following tests in accordance with ASTM C140.
         1) Compressive Strength
         2) Absorption
         3) Weight
         4) Moisture Content
         5) Dimensions
   3. Mortar Tests:
      a. Preconstruction: Perform the following tests in accordance with ASTM C780 on each type of mortar mix used on the Project.
      b. 28 Day Compressive Strength
      c. Water Retention
      d. Construction: Perform 28 day compressive strength test in accordance with ASTM C780 on each type of mortar mix used on the Project at the rate of one test per 2,000 square feet of masonry.
   4. Refer to and include Work for reinforcing steel specified.
   5. Grout Tests:
      a. Preconstruction: Perform the following tests in accordance with ASTM C1019 on each type of grout mix used on the Project.
         1) Slump Test
         2) 28 Day Compressive Strength
         3) Construction: Perform 28 day compressive strength test in accordance with ASTM C1019 on each type of grout mix used on the Project at the rate of one (1) test per 2,000 square feet of masonry.
         4) Prism Test: Perform preconstruction 28 day compressive strength test on concrete masonry walls in accordance with ASTM E447-97, Method B.

3.20 REPAIR AND PROTECTION

A. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 30.

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 01 45 20

01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, and security and protection facilities. Also reference Owners Special Conditions.

B. Support Facilities, including but not limited to the following:
1. Field offices
2. Storage and fabrication sheds
3. Temporary roads and paving
4. Traffic controls
5. Parking
6. Dewatering facilities and drains
7. Project identification and temporary signs
8. Waste disposal facilities
9. Lifts and hoists
10. Temporary elevator usage
11. Temporary stairs
12. Construction aids and miscellaneous services and facilities

C. Temporary Utilities, including but not limited to the following:
1. Sewers and drainage
2. Water service and distribution
3. Sanitary facilities, including toilets and drinking-water facilities
4. Heating and cooling facilities
5. Ventilation and humidity control
6. Electric power service
7. Lighting
8. Telephone service
9. Electronic communications service

D. Security and Protection Facilities, including but not limited to the following:
1. Environmental protection
2. Storm water control
3. Pest control
4. Site enclosure fence
5. Security enclosure and lockup
6. Security cameras where required by Owner
7. Barricades, warning signs, and lights
8. Temporary means of egress
9. Covered walkways
10. Temporary enclosures
11. Temporary partitions
12. Temporary fire protection

E. Related Sections include the following:
   1. Division 01, Section "Summary of Work" for work restrictions and limitations on utility interruptions.
   2. Division 01, Section "Temporary Tree and Plant Protection" for protection of trees and vegetation in work areas.
   3. Division 01, Section “Erosion and Sedimentation Control” for temporary measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties.

1.2 DEFINITIONS:

A. Permanent Enclosure: As determined by Architect, includes as a minimum, the following:
   1. Permanent or temporary roofing is complete, insulated, and weathertight, including parapets and roof edge terminations.
   2. Exterior walls are insulated, weathertight, and UV-resistant.
   3. All openings are closed with permanent construction or substantial weathertight temporary closures.
   4. Permanent enclosure envelope shall be capable of retaining controlled interior temperature and humidity levels.

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 construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction. Contractor shall be accountable for wasteful usage of Owner provided utilities.

B. 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.

C. Electric Power Service: Pay electric power service use charges for electricity used by all entities for construction operations.

1.4 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. 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.
   1. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water and dirt from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

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 and ICC/ANSI A117.1.

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.

B. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:
1. Keep temporary services and facilities clean and neat.
2. Relocate temporary services and facilities as required by progress of the Work.
3. At earliest feasible time, when acceptable to Owner, change over from use of temporary service to use of permanent service.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Architect. Provide materials suitable for use intended.

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.
1. Provide concrete or galvanized steel bases for supporting posts.

C. Wood Enclosure Fence: Plywood, 8 feet high, framed with four 2-by-4-inch rails, with preservative-treated wood posts spaced not more than 8 feet apart.

D. Lumber and Plywood: Comply with requirements in Division 06, Section "Miscellaneous Carpentry,"

2.2 TEMPORARY FACILITIES

A. Field Offices: Prefabricated with lockable entrances, operable windows, and serviceable finishes; heated and air conditioned; on foundations adequate for normal loading.

B. Common-Use Field Office: Provide an insulated, weathertight, air-conditioned field office for use as a common facility by all personnel engaged in construction activities; of sufficient size to accommodate required office personnel and meetings of 15 persons at Project site. 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. Water cooler and private toilet complete with water closet, lavatory, and medicine cabinet with mirror.
3. Provide a room of not less than 240 sq. ft. for Project meetings. Furnish room with conference table, 15 folding chairs, and minimum 4-foot- square tack board.
4. Provide resilient floor covering, painted gypsum wallboard or wood paneled walls, and acoustical ceiling. Provide operable windows with adjustable blinds and insect

screens.
5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
6. Provide fluorescent light fixtures capable of maintaining average illumination of 20 fc at desk height. Provide 110- to 120-V duplex outlets spaced at not more than 12-foot intervals, 1 per wall in each room.

C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility services. Sheds may be open shelters or fully enclosed spaces within building or elsewhere on-site.
1. Construct framing, sheathing, and siding using fire-retardant-treated lumber and plywood.
2. Paint exposed lumber and plywood with exterior-grade acrylic-latex emulsion over exterior primer.

2.3 EQUIPMENT

A. Fire Extinguishers: Hand carried, portable, UL rated. Provide class and extinguishing agent as indicated or a combination of extinguishers of NFPA-recommended classes for exposures.
1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

B. Self-Contained Toilet Units: Single-occupant units of chemical, aerated recirculation or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

C. Drinking-Water Fixtures: Containerized, bottled-water drinking-water units, including paper cup supply.
1. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 to 55 deg F .

D. HVAC Equipment: Unless Owner authorizes use of permanent heating 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, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use for type of fuel being consumed.
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".

E. Electrical Outlets: Properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-V plugs into higher-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.

F. Power Distribution System Circuits: Where permitted and overhead and exposed for surveillance, wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic sheathed cable.

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.

B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. 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. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.
   1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
   2. Provide adequate capacity at each stage of construction. Before temporary utility is available, provide trucked-in services.
   3. Obtain easements to bring temporary utilities to Project site where Owner's easements cannot be used for that purpose.

B. Uninterrupted utility services to the existing facilities are imperative. Provide temporary utilities as necessary during required change over times for each utility to ensure uninterrupted service.

C. Sewers and Drainage: If sewers are available, provide temporary connections to remove effluent that can be discharged lawfully. If sewers are not available or cannot be used, provide drainage ditches, dry wells, stabilization ponds, and similar facilities. If neither sewers nor drainage facilities can be lawfully used for discharge of effluent, provide containers to remove and dispose of effluent off-site in a lawful manner.
   1. Filter out excessive soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.
   2. Maintain temporary sewers and drainage facilities in a clean, sanitary condition. After heavy use, restore normal conditions promptly.
   3. Provide temporary filter beds, settlement tanks, separators, and similar devices to purify effluent to levels acceptable to authorities having jurisdiction.

D. Water Service: Use of Owner's existing water service 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.
   1. As soon as water is required at each level, extend service to form a temporary water- and fire-protection standpipe. Provide distribution piping. Space outlets so water can be reached with a 100-foot (30-m) hose. Provide one hose at each outlet.
   2. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.

E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities.
   1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
   2. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.
   3. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material

handled.
a. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.
4. Drinking-Water Facilities: Provide bottled-water, drinking-water units.
a. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 to 55 deg F.
5. Locate toilets and drinking-water fixtures so personnel need not walk more than two stories vertically or 200 feet horizontally to facilities.

F. Heating and Cooling: Provide temporary heating and cooling required by

G. 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 from that specified 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.

H. Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnecting means, automatic ground-fault interrupters, and main distribution switchgear.
1. Connect temporary service to Owner's existing power source, as directed by electric company officials.

I. Electric Distribution: Provide receptacle outlets adequate for connection of power tools and equipment complete with ground fault protection.
1. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
2. Provide warning signs at power outlets other than 110 to 120 V.
3. Provide metal conduit, tubing, or metallic cable for wiring exposed to possible damage. Provide rigid steel conduits for wiring exposed on grades, floors, decks, or other traffic areas.
4. Provide metal conduit enclosures or boxes for wiring devices.
5. Provide 4-gang outlets, spaced so 100-foot extension cord can reach each area for power hand tools and task lighting. Provide a separate 125-V ac, 20-A circuit for each outlet.

J. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations and traffic conditions.
1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
2. Install exterior-yard site lighting that will provide adequate illumination for construction operations, traffic conditions, and signage visibility when the Work is being performed.

K. Telephone Service: Provide temporary telephone service throughout construction period for common-use facilities used by all personnel engaged in construction activities. Install separate telephone line for each field office and first-aid station.
1. Provide additional telephone lines for the following:
a. In field office with more than two occupants, install a telephone for each additional occupant or pair of occupants.
b. Provide a dedicated telephone line for each facsimile machine

c. Provide high-speed internet service for each computer with modem in each field office.
d. Provide a separate telephone line for Owner's use.

2. At each telephone, post a list of important telephone numbers.
   a. Police Department
   b. Fire Department
   c. Ambulance service
   d. Contractor's home office
   e. Architect's office
   f. Engineers' offices
   g. Owner's office
   h. Principal subcontractors' field and home offices
3. Provide a portable cellular telephone with voice-mail capability for superintendent's use in making and receiving telephone calls when away from field office.

L. Electronic Communication (E-mail) Service: Provide temporary electronic communication service, including electronic mail, in common-use facilities.
1. Provide broadband in primary field office.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:
1. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
2. 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.
3. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate to support loads and to withstand exposure to traffic during construction period. Locate temporary roads and paved areas in same location as permanent roads and paved areas. 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 "Excavation and Fill."
3. Recondition base after temporary use, including removing contaminated material, re-grading, proof rolling, compacting, and testing.

C. Traffic Controls: Provide temporary traffic controls at junction of temporary roads with public roads. Include warning signs for public traffic and "STOP" signs for entrance onto public roads. 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. Dewatering Facilities and Drains: Comply with requirements in applicable Division 31 for temporary drainage and dewatering facilities and operations not directly associated with construction activities included in individual Sections. Where feasible, use same facilities. 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 property nor endanger permanent Work or temporary facilities.

2. Before connection and operation of permanent drainage piping system, provide temporary drainage where roofing or similar waterproof deck construction is completed.

E. Project Identification and Temporary Signs: Prepare Project identification and other signs in sizes indicated. Install signs where indicated to inform public and persons seeking entrance to Project. Do not permit installation of unauthorized signs.
1. Engage an experienced sign painter to apply graphics for Project identification signs. Comply with details indicated.
2. Prepare temporary signs to provide directional information to construction personnel and visitors.
3. Construct signs of exterior-type Grade B-B high-density concrete form overlay plywood in sizes and thicknesses indicated. Support on posts or framing of preservative-treated wood or steel.
4. Paint sign panel and applied graphics with exterior-grade alkyd gloss enamel over exterior primer.

F. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Containerize and clearly label hazardous, dangerous, or unsanitary waste materials separately from other waste. Comply with Division 01, Section "Common Execution Requirements" for progress cleaning requirements.
1. If required by authorities having jurisdiction, provide separate containers, clearly labeled, for each type of waste material to be deposited.
2. Develop a waste management plan for Work performed on Project. Indicate types of waste materials Project will produce and estimate quantities of each type. Provide detailed information for on-site waste storage and separation of recyclable materials. Provide information on destination of each type of waste material and means to be used to dispose of all waste materials.

G. Janitorial Services: Provide janitorial services on a weekly basis for temporary offices, first-aid stations, toilets, wash facilities, lunchrooms, and similar areas. General cleaning shall be done by Contractor daily.

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

I. Temporary Elevator Use: See Division 14 elevator Section for temporary use of new elevators.

J. 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 in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near Project site.

B. Storm water Control: Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm

water from heavy rains. Comply with Division 01 Section, “Erosion and Sedimentation Control”.

C. Tree and Plant Protection: Comply with requirements specified in Division 01, Section "Temporary Tree and Plant Protection."

D. Pest Control: Before deep foundation work has been completed, retain a local exterminator or pest-control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Engage this pest-control service 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. Maintain site free of food scraps which might attract pests.

E. Site Enclosure Fence: Before construction operations begin, install heavy wire mesh or chain-link enclosure fence with lockable entrance gates. Locate where indicated, or enclose entire Project site or portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering site except by entrance gates. Comply with Owner’s Special Conditions, Project Fencing section 2.5.
   1. Set fence posts in compacted mixture of gravel and earth.
   2. Provide gates in sizes and at locations necessary to accommodate delivery vehicles and other construction operations.
   3. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys.

F. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

G. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erecting structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard. Where appropriate and needed, provide lighting, including flashing red or amber lights.
   1. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch-thick exterior plywood.

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

I. 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 weathertight enclosure for building exterior.
   1. Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
   2. Vertical Openings: Close openings of 25 sq. ft. or less with plywood or similar materials.
   3. Horizontal Openings: Close openings in floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
   4. Install tarpaulins securely using fire-retardant-treated wood framing and other materials.
   5. Where temporary wood or plywood enclosure exceeds 100 sq. ft. in area, use fire-retardant-treated material for framing and main sheathing.

J. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
   1. Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above.
      a. Field Offices: Class A stored-pressure water-type extinguishers.
      b. Other Locations: Class ABC dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for exposures.
      c. Locate fire extinguishers where convenient and effective for their intended purpose; provide not less than one extinguisher on each floor at or near each usable stairwell.
   2. Store combustible materials in containers in fire-safe locations.
   3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for firefighting. Prohibit smoking in hazardous fire-exposure areas.
   4. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition.
   5. Permanent Fire Protection: At earliest feasible date in each area of Project, complete installation of permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.
   6. Develop and supervise an overall fire-prevention and first-aid fire-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.

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. Remove and replace materials with mold.

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 material 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.

E. Wet and Water-Damaged Materials:
1. 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 24 hours are considered defective.
2. 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.
3. Remove materials that cannot 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. Protect from damage caused by freezing temperatures and similar elements.
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.
2. Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Temporary Facility Changeover: Except for using permanent fire protection as soon as available, 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 the property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements in Division 01, Section "Closeout Procedures."

END OF SECTION

01 60 00

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 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.

B. Related Sections include:
1. Division 01 Section “Allowances” for products selected under an allowance.
2. Division 01 Section “Alternates” for products selected under an alternate.
3. Division 01 Section “Substitution Procedures” for requests for substitutions.
4. Division 01 Section “References” for applicable industry standards for products specified.

1.2 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 or recycled 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.

1.3 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. Note that no substitutions for convenience are allowed according to Division 01 Section “Substitutions.”
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.

1.4 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.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft 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. Protect 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.

1.6 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. See other 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.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

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.
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.
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers and/or products, 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. Note that substitutions for convenience are not allowed according to Division 01 Section “Substitutions.” 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, 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 applicable to this Section

END OF SECTION

01 72 00

COMMON EXECUTION REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
1. Construction layout.
2. Field engineering and surveying.
3. General installation of products.
4. Coordination of Owner-installed products.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.
8. Correction of the Work.

B. Related Sections include the following:
1. Division 01 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
2. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.2 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor 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.

B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.

C. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

D. Certified Surveys: Submit two copies signed by land surveyor.

E. Final Property Survey: Submit two copies showing the Work performed and record survey data.

1.3 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.

PART 2 PRODUCTS – Not Applicable to this Section

PART 3 EXECUTION

3.1 EXAMINATION

A. Acceptance of Conditions: 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: Provide a written report listing conditions detrimental to performance of any and all Work, 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 primers.
   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. Field Measurements: Take field measurements as required to fit the Work properly. Recheck 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.

B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents. Submit requests on CSI Form 13.2A, "Request for Information" form included at the end of in Division 01 Section “Substitutions.”

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 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 site work.

E. Final Property Survey: Prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, 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, comply with provisions of Section 01 31 06. 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.
4. Maintain minimum headroom clearance of 8 feet in spaces without a suspended ceiling.

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 produces 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. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
1. Mounting Heights: Where mounting heights are not indicated, request clarification and 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 OWNER-INSTALLED PRODUCTS

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

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces, AV, IT, etc.
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. Preinstallation Conferences: Include Owner's construction forces at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
   1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
   2. Assure there are no significant food matters in dumpster.
   3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

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: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
   1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

H. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

I. 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.

J. 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.

K. 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.

3.8 STARTING AND ADJUSTING

A. Manufacturer's representative shall be present for initial start up.

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust operating components for proper operation without binding. Adjust equipment for

proper operation.

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: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."

3.9 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.

3.10 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
   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

01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

1.2 DEFINITIONS

A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

C. Cutting and patching is performed for coordination of the Work, to uncover Work for access or inspection, to obtain samples for testing, to permit alterations to be performed or for other similar purposes.

D. Restoring or removing and replacing non-complying work is specified separately from cutting-and-patching, but may require cutting-and-patching operations as specified herein.

1.3 INFORMATIONAL SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
3. Products: List products to be used and firms or entities that will perform the Work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
7. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.4 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. 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.
1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Fire-protection systems.
4. Control systems.
5. Communication systems.
6. Conveying systems.
7. Electrical wiring systems.
8. Operating systems of special construction in Division 13 Sections.

C. Miscellaneous Elements: Do not cut and patch the following elements or related 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.
1. Water, moisture, or vapor barriers.
2. Membranes and flashings.
3. Exterior curtain wall construction.
4. Equipment supports.
5. Piping, ductwork, vessels, and equipment.
6. Noise- and vibration-control elements and systems.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces 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.
1. If possible, retain original Installer or fabricator to cut and patch exposed Work listed below. If it is impossible to engage original Installer or fabricator, engage another recognized, experienced, and specialized firm.
   a. Processed concrete finishes.
   b. Stonework and stone masonry.
   c. Ornamental metal.
   d. Matched-veneer woodwork.
   e. Preformed metal panels.
   f. Roofing.
   g. Firestopping.
   h. Window wall system.
   i. Stucco and ornamental plaster.
   j. Terrazzo.
   k. Finished wood flooring.
   l. Fluid-applied flooring.
   m. Aggregate wall coating.
   n. Wall covering.
   o. HVAC enclosures, cabinets, or covers.

E. 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.

1.5 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during 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 of these Specifications.

B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
   1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
   1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
   2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect existing 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.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid interruption of services to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

B. Execute cutting, fitting and patching, including excavation and fill, to complete work and to:
   1. Fit the several parts together to integrate with other work.
   2. Uncover work to install ill-timed work.
   3. Remove and replace defective and nonconforming work.
   4. Remove samples of installed work for testing.
   5. Provide openings in elements of work for penetrations of mechanical and electrical work.
   6. Cut existing 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.

C. Cutting: Cut existing 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 as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Existing 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.

D. 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 possible. Provide materials and comply with installation requirements specified in other Sections.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate 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 eliminate 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 existing 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, apply primer and intermediate paint coats 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 rehang existing 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 weathertight condition.

E. Fire Rated Construction: At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 13, to full thickness of the penetrated element.

F. Roofing: Where penetrations are made through the roof system to accommodate mechanical, electrical, or plumbing systems, or any other reason associated with the Work, repair in accordance with the original manufacturer’s requirements. Install curbs, cants, flashing and other roof system components in accordance with Specifications within this Project Manual and recommendations by the manufacturer of the roof system presently in place. Return assembly to weather-tight condition. Also refer to Division 07 section on roof modifications or repairs.

G. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely

remove paint, mortar, oils, putty, and similar materials.

END OF SECTION

01 77 00

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
1. Inspection procedures.
2. Texas Accessibility Standards (TAS) inspection
3. Warranties
4. Instruction of Owner's personnel
5. Final cleaning
6. Owner's standard of care

1.2 SUBSTANTIAL COMPLETION

A. "Substantial Completion" is the stage in the progress of Work when Work or designated portion thereof is sufficiently complete in accordance with Contract Documents so Owner can occupy or utilize Work for use which it is intended.
1. Work will not be considered suitable for Substantial Completion review until all systems and equipment are operational; all designated or required governmental inspections and certifications have been made and posted, designated instruction of Owner's personnel in operation of systems and equipment has been completed, operation and maintenance data has been satisfactorily turned over to the Owner, and all finishes are in place. In general, the only remaining Work shall be minor in nature, such that the Owner could occupy project or designated portion thereof on following day, and completion of Work by Contractor would not materially interfere or hamper Owner's normal business operations.

B. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
1. Prepare a list of items to be completed and corrected (punch list), 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 photographs and photographic negatives, damage or settlement surveys, property surveys, and similar final record information.
6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
8. Complete startup testing of systems.
9. Terminate and remove temporary facilities from Project site, along with mockups,

construction tools, and similar elements.
10. Advise Owner of changeover in heat and other utilities.
11. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
12. Complete final cleaning requirements, including touchup painting.

C. 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.

1.3 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of 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.
4. Submit pest-control final inspection report and warranty.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
6. Submit test/adjust/balance records.
7. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

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.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies 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 attached CSI Form, or substantially similar form, and forward to Architect at time of request for Substantial Completion inspection. Architect may use same form for Architect’s supplemental items to Contractor.
1. Organize list of spaces in sequential order.
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

1.5 TEXAS ACCESSIBILITY STANDARD INSPECTION

A. Provide inspection prior to Final Completion of facility in accordance with rules and regulation of the Texas Department of Licensing and Regulations (TDLR) for the purpose of determining compliance with the Texas Accessibility Standards. Inspector must be licensed with the Texas Department of Licensing and Regulations to perform the required inspection.

B. Upon receipt of Inspector's report, immediately make corrections of any reported non-compliant items. Provide documentation to Owner of completed corrective measures.

1.6 PROJECT RECORD DOCUMENTS

A. Refer to Section 01 78 39.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Refer to Section 01 78 23.

1.8 WARRANTIES

A. Refer to Section 01 78 36.

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.

PART 3 EXECUTION

3.1 DEMONSTRATION AND TRAINING

A. Refer to Section 01 79 00.

3.2 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and anti-pollution 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 that is acceptable to the Owner and consistent with the Owner's standards of care. 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. 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.
f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
g. Sweep concrete floors broom clean in unoccupied spaces.
h. Power-wash concrete paving and parking areas, and concrete decks of parking garages.
i. Vacuum carpet and similar soft surfaces, including millwork, 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 similar labels, 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 unusual operating conditions.
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.
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 as acceptable to the Owner and their standards.

C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

3.3 FORMS (REFERENCE):

A. Section 01 77 00x.....Completion/Correction Form, CSI Form 14.1A.

B. Section 01 77 00xx.....Project Close-Out Checklist

C. Section 01 77 00xxx.....Facilities Infrastructure Asset Inventory Form.

END OF SECTION

01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUMMARY

A. This 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. Maintenance manuals for the care and maintenance of products, materials, and finishes, systems and equipment.

B. Related Sections include the following:
   1. Division 01, Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
   2. Divisions 02 through 49 for specific operation and maintenance manual requirements for the Work in those Sections.

1.2 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.

1.3 SUBMITTALS

A. Ensure compliance with Uniform General and Supplemental Conditions.

B. Initial Submittal: Submit 2 draft copies of each manual at least 15 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Architect will return 1 copy of draft and mark whether general scope and content of manual are acceptable.

C. Final Submittal: Submit 1 copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 days after final inspection.
   1. Correct or modify each manual to comply with Architect's comments. Submit one hard copy for Facilities and one electronic copy for FP&C (.pdf) of each corrected manual within 15 days of receipt of Architect's comments.

1.4 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

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 the 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 MANUALS, GENERAL

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
3. Manual contents

B. Title Page. Enclose title page in transparent plastic sleeve. 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, address, and telephone number of Contractor
6. Name and address of Architect
7. 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.
1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary

to accommodate contents, sized to hold 8-1/2 X 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. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. 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 diskettes for computerized electronic equipment.

4. Supplementary Text: Prepared on 8-1/2 X 11-inch, 20-lb/sf white bond paper.

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
3. Gas leak
4. Water leak
5. Power failure
6. Water outage
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:
   1. System, subsystem, and equipment descriptions
   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
   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
   6. Normal shutdown instructions
   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 MANUAL

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.

C. Product Information. Include the following, as applicable:
   1. Product name and model number
   2. Manufacturer's name
   3. Color, pattern, and texture
   4. Material and chemical composition
   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. Contact data for all equipment and warranty issues - post in view on all equipment.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

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 the 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.

C. Manufacturers' Maintenance Documentation. Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
   1. Standard printed 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 videotape, 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 - post in view of/on all equipment.

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

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

PART 3 EXECUTION

3.1 MANUAL PREPARATION

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 complete set of emergency information indicating procedures for use by emergency personnel and 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. with Division 01, Section "Closeout Procedures" for the schedule for submitting operation and maintenance documentation.

END OF SECTION

02 00 00

EXISTING CONDITIONS

PART 1 GENERAL

1.1 RELATED SECTIONS

A. 00 31 32 Geotechnical Report

B. 01 40 00 Quality Requirements

C. 01 70 00 Execution and Closeout Requirements

1.2 SUMMARY

A. Use of Survey provided in Project Documents.

B. Construction Work on site.

C. Unforeseen Conditions.

D. Special considerations in existing spaces.

PART 2 PRODUCTS - Not applicable to this Section

PART 3 EXECUTION

3.1 EXISTING CONDITIONS REPRESENTED ON SITE SURVEY

A. Existing site setbacks and easements shall be respected throughout construction, unless express written permission is given by the Owner to do otherwise.
   1. Omission of setbacks and easements from the Architectural and/or Civil Site Drawings does not absolve the Contractor from Following Setbacks indicated in the Survey.

B. Existing utilities, sewers, or other services on site that serve other structures or properties shall be protected during construction.
   1. Architect must be notified at once if utilities, sewers, or other services not appearing on the Survey are discovered on site.
   2. Architect must be notified at once if utilities, sewers, or other services conflict with proposed work.

3.2 EXISTING STRUCTURES AND FACILITIES ON SITE.

A. Construction Operations: Do not damage building elements and improvements indicated to remain.

B. Utilities: Locate, identify, disconnect, and seal or cap off utilities in buildings to be demolished.

C. Occupied Structures and Adjacent Facilities: Do not close or obstruct streets, walks, drives or other occupied or used spaces or facilities without the written permission of the Owner and the authorities having jurisdiction. Do not interrupt utilities serving occupied or used facilities without the written permission of the Owner and authorities having jurisdiction. If necessary, provide temporary utilities.

D. Operations: Cease operations if public safety or remaining structures are endangered. Perform temporary corrective measures until operations can be continued properly.

E. Security: Provide adequate protection against accidental trespassing. Secure project after work hours.

F. Restoration: Restore sidewalks, driveways, landscape, and other site elements indicated to remain, if damaged by construction.

3.3 UNFORESEEN CONDITIONS

A. Notify Architect at once of any unforeseen conditions on site that may affect the work.

3.4 SPECIAL CONSIDERATIONS IN EXISTING SPACES

A. Contractor shall visually confirm structural integrity of existing walls, floors, and other structural members indicated to remain upon start of work.

B. Contractor shall review and document the condition of interior items indicated to remain upon start of work. These items shall be protected as indicated in the drawings:
   1. Mechanical Equipment
   2. Electrical Equipment
   3. Light Fixtures
   4. Plumbing Equipment and Fixtures
   5. Conveyance Equipment
   6. Nonstructural Partitions
   7. Doors.
      a. Documentation shall include assessment of proper functioning of hardware (including closers), and presence of round “knob” door handles.
   8. Windows
      a. Documentation shall include assessment of proper functioning of operable windows (including security windows).
   9. Furnishings.
      a. Where furnishings disrupt the progress of work, arrangements shall be made with the Owner for the proper storage of the furnishings.
   10. Other appurtenances and equipment present in the space and indicated to remain, including but not limited to systems furniture, residential and commercial kitchen equipment, shop equipment, office equipment, laundry equipment, lab and medical equipment, and other items found in the building.
      a. Where appurtenances and equipment disrupt the progress of work, arrangements shall be made with the Owner for the proper storage of the appurtenances and equipment.
      b. Plumbing and Mechanical connections to existing appurtenances and equipment shall be temporarily capped-off when appurtenances and equipment are disconnected.
      c. Electrical circuits serving existing appurtenances and equipment shall be labeled at the breaker, and the breaker turned to ‘off’ position when appurtenances and equipment are disconnected.

C. Upon start of work, Contractor shall review Mechanical, Electrical, and Plumbing equipment indicated to be removed and/or replaced, for verification of work done by other parties prior to this project.

END OF SECTION

02 41 19

SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. Selective Site Demolition:
1. Demolition of designated site improvements including paving, curbing, site walls, and utility structures.
2. Demolition of below-grade foundations and site improvements to depth to avoid conflict with new construction or site work.
3. Removal of hollow items or items which could collapse.
4. Salvage of designated items.
5. Protection of site work and adjacent structures.
6. Disconnection, capping, and removal of utilities.
7. Pollution control during building demolition, including noise control.
8. Removal and legal disposal of materials.
9. Designated site improvements and adjacent construction.
10. Interruption, capping or removal of utilities as applicable.

B. Selective Building Demolition:
1. Selective demolition of interior partitions, systems, and building components designated to be removed.
2. Selective demolition of exterior facade, structures, and components designated to be removed.
3. Protection of portions of building adjacent to or affected by selective demolition.
4. Removal of abandoned utilities and wiring systems.
5. Notification to Owner of schedule of shut-off of utilities which serve occupied spaces.
6. Pollution control during selective demolition, including noise control.
7. Removal and legal disposal of materials.
8. Protection of designated site improvements and adjacent construction.
9. Salvage of designated items.
10. Interruption, capping or removal of utilities as applicable.

C. Hazardous Materials:
1. Not present.
2. Removed under separate prior contract.
3. Removed as a part of this contract.

1.2 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Schedule: Submit for approval selective demolition schedule, including schedule and methods for capping utilities to be abandoned and maintaining existing utility service.

1.3 QUALITY ASSURANCE

A. Codes and Regulations: Comply with governing codes and regulations. Use experienced workers.

1.4 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work of this section.

1.5 SEQUENCING

A. Immediate areas of work will not be occupied during selective demolition. The public, including children, may occupy adjacent areas.

B. No responsibility for buildings and structures to be demolished will be assumed by the Owner.

C. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

PART 2 PRODUCTS - Not applicable to this Section.

PART 3 EXECUTION

3.1 SELECTIVE DEMOLITION

A. Demolition Operations: Do not damage building elements and improvements indicated to remain. Items of salvage value, not included on schedule of salvage items to be returned to Owner, shall be removed from structure. Storage or sale of items at project site is prohibited.

B. Utilities: Locate, identify, disconnect, and seal or cap off utilities in buildings to be demolished.

C. Shoring and Bracing: Provide and maintain interior and exterior shoring and bracing.

D. Occupied Spaces: Do not close or obstruct streets, walks, drives or other occupied or used spaces or facilities without the written permission of the Owner and the authorities having jurisdiction. Do not interrupt utilities serving occupied or used facilities without the written permission of the Owner and authorities having jurisdiction. If necessary, provide temporary utilities.

E. Operations: Cease operations if public safety or remaining structures are endangered. Perform temporary corrective measures until operations can be continued properly.

F. Security: Provide adequate protection against accidental trespassing. Secure project after work hours.

G. Restoration: Restore finishes of patched areas.

3.2 SCHEDULE

A. Refer to Demolition and Construction Plans for:
1. Items for Protection During Demolition and Construction.
2. Items to be Salvaged for Reinstallation.
3. Items to be Salvaged for Delivery to Owner.
4. Utilities Requiring Interruption, Capping, or Removal.

END OF SECTION

SECTION 03 05 80 - UNDER-SLAB VAPOR BARRIER/RETARDER

PART 1 - GENERAL

1.1 SUMMARY

A. Products Supplied Under This Section
   1. Vapor Barrier, seam tape, mastic, pipe boots, detail strip for installation under concrete slabs.

B. RELATED SECTIONS
   1. Section 03 30 00 Cast-in-place Structural Concrete
   2. Section 01 45 23 Structural Testing and Inspection

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM E 1745-97 (2004) Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
   2. ASTM E 154-88 (2005) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs
   3. ASTM E 96-95 Standard Test Methods for Water Vapor Transmission of Materials
   4. ASTM E 1643-98 (2005) Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

B. American Concrete Institute (ACI)
   1. ACI 302.2R-06 Vapor Barrier Component (plastic membrane) is not less than 10 mils thick.

1.3 SUBMITTALS

A. Quality Control / Assurance
   1. Full set of test results as per paragraph 8.3 of ASTM E 1745.
   2. Manufacturer's samples, literature
   3. Manufacturer's installation instructions for placement, seaming and pipe boot installation.

1.4 SUBSTITUTIONS

A. Product Review
   1. Request must be made 14 days prior to bid date to allow time for proper review. Reviews will be at contractor's expense.
   2. Independent laboratory test results showing compliance with ASTM E 1745 Class A, a permeance less than 0.01 Perms (grains/(ft2 *hr * in. Hg) before and after the mandatory conditioning tests ASTM E 154 Sections 8,11,12, and 13. (Woven, and recycled plastics are not permitted
   3. Incomplete substitutions will not be accepted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Vapor Barrier (Performance based specification). When the specifications of different sections conflict, the contractor shall perform to the most restrictive provision. Vapor Barrier membrane must have the following properties.
   1. Permeance as tested after mandatory conditioning (ASTM E 154 sections 8,11,12,13) less than 0.01 Perms [grains/(ft2 *hr * in.Hg)]
   2. Other performance criteria
      a. Strength: ASTM E 1745 Class A
      b. Thickness: 15 mils minimum

2.2 ACCESSORIES

A. Seam Tape
   1. Tape must have the following qualities:
      a. Water Vapor Transmission Rate ASTM E 96, 0.3 perms or lower
   2. Seam Tape
      a. Manufacturer's standard seam tape.
      b. Stego Crete Claw (for slabs on void boxes).

B. Vapor Proofing Mastic
   1. Mastic must have the following qualities:
      a. Water Vapor Transmission Rate ASTM E 96 0.3 perms or lower

C. Pipe Boots
   1. Construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ensure that subsoil is approved by architect or geotechnical firm
   1. Level and tamp or roll aggregate, sand or tamped earth base.

3.2 INSTALLATION

A. Install Vapor Barrier/Retarder:
   1. Installation shall be in accordance with manufacturer's written instructions and ASTM E 1643-09.
      a. Unroll Vapor Barrier/Retarder with the longest dimension parallel with the direction of the pour.
      b. Lap Vapor Barrier/Retarder over footings or seal to foundation walls.
      c. Overlap joints 6 inches and seal with manufacturer's tape.
      d. Seal all penetrations (including pipes) per manufacturer's instructions.

e. No penetration of the Vapor Barrier/Retarder is allowed except for reinforcing steel and permanent utilities.

f. Repair damaged areas by cutting patches of Vapor Barrier/Retarder, overlapping damaged area 6 inches and taping all four sides with tape.

END OF SECTION 03 05 80

SECTION 03 10 00 FORMWORK

PART 1 GENERAL

1.01 REQUIREMENTS, CODES:

A. All applicable portions of Division 1 - The Contract for Construction, along with General, and Supplementary Conditions of the Contract for Construction are to be considered as included with this section.

B. The following are minimum requirements and shall govern, except that all federal, local and/or state codes and ordinances shall govern when their requirements are in excess hereof.

1.02 DESCRIPTION:

A. Provide all materials, labor, equipment, service, scaffolding, etc., necessary and incidental to the supply and placing of all formwork as shown on the drawings and as specified herein.

B. Work included consists of but is not limited to the following:

1. Concrete floor, grade beams, footings, and sonotube forms.
2. Equipment bases and curbs.
3. Pavement, sidewalks, exterior slabs, pads, ramps, curbs, etc.

C. Work installed but furnished by others:

1. Setting of miscellaneous rough hardware, bolts, dowels, etc. Those items embedded in flat work concrete, not requiring formwork, shall be set by concrete contractor.

1.03 FORMING REQUIREMENTS:

A. Forms shall be used, wherever necessary to confine the concrete and shape it to the required dimensions. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

B. Earth cuts may be used to form concealed vertical surfaces of footings, grade beams, walls, piers, etc. Earth forms shall be sharp and true to line and dimensions.

C. Provide all forms as required to form poured in place curbs, combination curb and gutters, sidewalks, exterior slabs, ramps, aprons, light pole bases, etc.

1.04 QUALITY ASSURANCE:

A. The design, engineering and construction of all formwork shall be the responsibility of the formwork subcontractor. Formwork design, allowable loads, lateral pressure and stresses shall be in accordance with Recommended Practice for Concrete Formwork ACI 347 and for wind loads and other applicable requirements of the controlling local building code.

1. Tolerances for formed concrete shall not exceed ACI standards.
2. This subcontractor shall maintain sufficient control points and bench marks to establish and maintain specified tolerances.

1.05 JOB CONDITIONS:

A. Make provisions for, coordinate with and provide access to Mechanical and Electrical Contractor for the installation of required pipe sleeves, conduit, etc.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Steel forms or form liners shall be standard commercially available prefabricated steel forms.

B. Plywood forms shall be B-B plyform, Class I or Class II, 5/8" minimum thickness, edge sealed.

C. Boards, sheathing and form lumber shall be No. 3, common or better, ¾" minimum thickness.

D. Framing lumber shall be standard or better.

E. Form accessories embedded in concrete shall be commercially manufactured type. Non-fabricated wire ties are not permitted.

2.02 CONSTRUCTION

A. All forms used for exposed concrete work shall be new plywood forms. Reused plywood forms and standard steel forms may be used for all concealed concrete work.

B. All exterior corners and edges of exposed concrete shall be chamfered or bullnosed.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Rigidly support and substantially construct forms. Forms shall be erected plumb, straight, and true to line, shape and dimensions and in precise position to form the lines and designs indicated. Forms shall be suitable for removal without prying against the concrete. Make forms tight, without cracks or holes and prevent any leakage of mortar or loss of fine particles from the concrete. Knots that have loosened, leaving holes, holes that are not used and cracks that have opened up shall be covered with sheet metal for unexposed concrete. No loose knots, holes or cracks allowed for exposed concrete.

1. Walls and studding shall be of adequate size, strength, bracing and spacing, to prevent bulging or sagging.
2. Provide form ties and spreaders as required to form concrete to proper thickness and dimension. Use steel rods, cones snap ties or other similar commercially available devices.
3. Shores shall be substantial and located and installed to minimize deflection when superimposed loads are applied. Place on adequate bearing blocks to satisfactorily distribute the loads. Positive means of adjustment (wedges or jacks) of shores and struts shall be provided and all settlement shall be taken up during concrete placing operation.

B. Forms for concrete curbs, gutters, sidewalks, exterior slabs, pads, ramp, etc. shall be set directly in contact with prepared sub-grade which shall be compacted for a sufficient distance outside the area of the pavement to support the form.

1. Forms shall be securely staked, braced and tamped into position. Top surface of form shall be set within a tolerance of 1/8" in ten feet.

C. Surfaces of forms coming in contact with newly placed concrete shall be coated with an approved non-staining form oil, a commercial form release agent or a non absorptive form liner to prevent moisture penetration of the form and prevent bond with the concrete.

1. Do not permit coating to puddle or come in contact with reinforcing steel and hardened concrete at construction joints.

3.02 FORM REMOVAL:

A. Formwork may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations and developed sufficient strength to sustain its own weight and any superimposed loads.

Remove ends or end fasteners from form ties. Embedded portion of ties shall be ¾" minimum from the finish surface of all concrete "exposed to public view." Form ties fasteners, etc., may be cut or removed flush with the surface of concealed concrete.

END OF SECTION

SECTION 03 20 00 REINFORCEMENT

PART 1 GENERAL

1.01 REQUIREMENTS, CODES:

A. All applicable portions of Division 1 - The Contract for Construction, along with General, and Supplementary Conditions of the Contract for Construction are to be considered as included with this section.

B. The following are minimum requirements and shall govern, except that all federal, local and/or state codes and ordinances shall govern when their requirements are in excess hereof.

1.02 DESCRIPTION:

A. Provide all materials, labor, equipment, service, scaffolding, etc., necessary and incidental to the supply and placing of all reinforcing as shown on the drawings and as specified herein.

B. Work included consists of but is not limited to the following:

1. Reinforcement and dowels for all concrete footings, grade beams, foundation walls, piers, light pole bases, etc.
2. Welded wire fabric for sidewalks, pads, ramps, curbs, etc.

1.03 QUALITY ASSURANCE:

A. This Contractor shall be required to have available at all times, for reference, the latest editions of the following regulations, standards, etc. which are hereby included in and made part of these specifications.

1. Specification for Structural Concrete for Building ACI 301.
2. Building Code Requirements for Reinforced Concrete ACI 318.
3. Manual of Standard Practice of the Concrete Reinforcing Steel Institute and the Western Concrete Reinforcing Steel Institute.
4. Manual of Standard Practice for Detailing Reinforced Concrete Structures ACI 315.
5. Building Design Handbook of Welded Wire Fabric - Wire Reinforcement Institute.

B. All materials shall conform to specified ASTM standards.

1.04 DELIVERY AND STORAGE:

A. Reinforcing bars shipped from mill shall be properly separated and tagged with manufacturer's heat and/or test number.

B. All erection bars shall be shipped to the site and stored in such a manner as to prevent injurious defects and maintain a workmanlike finish.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Steel reinforcing bars shall conform to "Specifications for Deformed Billet - Steel Bars for Concrete Reinforcement", ASTM A-615 Grade Number 60, having a minimum yield strength of 60,000 p.s.i.

B. Tie wire shall be black annealed wire, 16 gauge minimum.

C. Bar supports shall conform to the "Bar Support Specification" contained in "manual of Standard Practice" as published by CRSI and WCRSI. Bar supports and accessories within 1/2" of surface of concrete exposed to weather shall be non-corrosive.

D. Welded Wire Fabric shall be smooth wire fabric conforming to ASTM A82 and A185. Welded intersection shall not exceed 12" o.c.

2.02 FABRICATION:

A. Fabricate reinforcing bars of size and length indicated. Accurately bend or form the shapes indicated by methods that will not injure the materials.

B. Fabrication and placing tolerances of reinforcing bars and welded wire fabric shall conform to CRSI and WCRSI "Manual of Standard Practice" and ACI 318 Building Code Requirements for Reinforced Concrete for Buildings.

C. Heating of reinforcement for bending will not be allowed.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Accurately place reinforcement and securely tie in precise position, using at least 16-gauge annealed steel wire at points where bars cross, and in such a way as to hold them against displacement during the placing of concrete. Welding of reinforcement bars must have prior approval of Architect.

B. Reinforcing bars shall be free from mud, oil, form release compounds or any other non-metallic coatings that adversely affect bonding properties. Rush and mill scale are permitted provided ASTM minimum standards are maintained.

C. Exercise particular care in placing and securing of reinforcement to maintain the proper distance and clearance between parallel bars and between bars and the forms, or neat excavations. Provide metal spreaders and spacers to maintain vertical steel centering, and to hold horizontal steel in position. Support steel at proper height with chairs, transverse steel bars, with hangers, or in other manner, as necessary. Support the par reinforcement for footings laid on earth, in proper position, using precast concrete cubes at frequent intervals. Architect or Owner's Project Representative shall be notified in advance of concrete pour so that they can inspect placement of reinforcing.

D. Do not make splices in reinforcing steel unless specifically shown on drawings or approved by the Architect.

E. Stubs and dowels required to receive and engage subsequent work shall extend a sufficient length to develop the strength of the bar. Place dowel and stub bars in the forms and secure against displacement during the placing of concrete. Thoroughly clean stub steel and dowels, extending through construction joint in wall, of adhering particles of concrete, before continuing the placing of any subsequent concrete.

F. Place, straighten and cut welded wire fabric to size, lap, support fabric in accordance with ACI, CRSI and WCRSI requirements. Avoid splices in areas of maximum stress.

1. Lift welded wire fabric into position during pour.

END OF SECTION

SECTION 03 30 00 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 REQUIREMENTS, CODES:

A. All applicable portions of Division 1 - The Contract for Construction, along with General, and Supplementary, Conditions of the Contract for Construction are to be considered as included with this section.

B. The following are minimum requirements and shall govern, except that all federal, local and/or state codes and ordinances shall govern when their requirements are in excess hereof.

1.02 DESCRIPTION:

A. Provide all materials, labor, equipment, service, scaffolding, etc., necessary and incidental to the completion of all cast-in-place concrete work as shown on the drawings and as specified herein.

B. Work included consists of, but is not limited to, the following:

1. Drilled piers, grade beams, floor slabs, ramps, concrete aprons, curbs, equipment bases, pads, exterior slabs, sidewalks, light pole bases, etc.

C. Related work specified elsewhere:

1. Concrete formwork.
2. Concrete reinforcement.
3. Setting of sleeves, etc., for mechanical or electrical work.
4. Paving, precast concrete curbs.

D. Work installed but furnished by others:

1. Setting and grouting of column leveling plates and anchor bolts.
2. Setting of angle frames, sill angles, railings sleeves, rough hardware, etc., embedded in concrete.
   a. Those items installed in formwork shall be set by formwork contractor.

1.03 QUALITY ASSURANCE:

A. This Contractor shall be required to have available, on site, at all times, for reference, the latest editions of the following regulations, standards, etc., which are hereby included in, and made a part of, these specifications.

1. Local Building Code.
   a. Building Code requirements for Reinforced Concrete, ACI 318.
   b. Specifications for Structural Concrete for Buildings, ACI 301.
   c. Recommended Practice for Concrete Floor and Slab Construction, ACI 302.
   d. Recommended Practice for Cold Weather Concreting, ACI 306.
   e. Recommended Practice for Hot Weather Concrete, ACI 305.
   f. Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete, ACI 304.

B. All concrete materials shall conform to specified ASTM and ACI standards.

1.04 PRODUCT DELIVERY AND STORAGE:

A. Cement shall be stored in weather tight buildings, bins or silos free of moisture and contaminants.

B. Aggregates shall be stored to avoid segregation and contamination. Frozen or partially frozen aggregates shall not be used.

C. Admixtures shall be stored to avoid contamination, evaporation, or damage. Protect from freezing or temperature changes which would affect admixture characteristics.

1.05 SUBMITTALS:

A. Submit a Letter of Intent describing the concrete mix to the Architect for approval.

1.06 JOB CONDITIONS:

A. Provide ample notice to other trades to facilitate installation of embedded items prior to concreting. Provide access to mechanical and electrical contractors for installation of sleeves, conduit, under floor raceway, etc.

1.07 ENVIRONMENTAL REQUIREMENTS:

A. Provide cold weather and/or hot weather protection as recommended in ACI 306 and ACI 305.

B. Unless adequate protection is provided, concrete shall not be placed during rain, sleet or snow. Protect concrete from rain water, maintain concrete water ratio and protect concrete surface.

C. All concrete shall be adequately protected after pouring to prevent damage from freezing, by the use of suitable covers and adequate heating equipment. Frozen and damaged concrete must be removed and replaced at the contractor's expense. Do not place concrete on frozen earth.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Cement shall be Gray Portland Cement, Type I or II, conforming to ASTM C-150 or ASM C-175 for air-entraining Portland Cement. Use same brand for all exposed work.

B. Water shall be potable, clean and free from impurities affecting the strength of the concrete.

C. Concrete aggregates shall conform to ASTM C-33.

1. Fine and coarse aggregates shall be regarded as separate ingredients and each shall conform to the appropriate grading requirements of ASTM C-33.

D. Air-entraining admixtures shall conform to ASTM C-260.

E. Non-shrinking grout shall be non-metallic, non-staining type conforming to ASTM C-827.

F. Expansion joints shall be 1/2" thick cane fiber expansion joints, conforming to ASM D-1751.

G. Vapor barrier shall be ten (10) mil minimum thickness Class A, polyethylene film.

H. Joint tape shall be 3M No. 890 or approved equal glass filament acetate tape.

I. Felt shall be No. 15 asphalt saturated plain organic conforming to ASTM D-226.

J. Curing compound shall be clear, conforming to ASTM C309, and shall be compatible with adhesives, mastics, etc. scheduled for application to concrete surface.

K. Concrete sealer shall be Brulin and Company, Inc., "Brulin Clear Cement Seal" masonry Columbia Company "Porfill."

2.02 CONCRETE MIX AND STRENGTH:

A. All concrete shall be normal weight concrete consisting of proportioned mixture of Portland cement, fine and coarse aggregate and water.

1. Concrete proportions shall be selected on the basis of trial mixes conforming to ACI 211.1.

B. All concrete unless otherwise noted, shall have a minimum compressive strength of 3,000 p.s.i. at 28 days. Mix design shall be so proportioned to provide a minimum of 376 pounds of cement per cubic yard.

1. 1500 PSI. concrete may be used for fill under slab. Mix design shall be so proportioned to provide a minimum of 376 pounds of cement per cubic yard.

C. All concrete unless otherwise noted, shall be proportioned to have a slump of 2½ " to 5" maximum. Tolerance in slump shall not exceed ACI recommendations.

1. Slump for concrete fill may be 6" maximum.

D. All exterior concrete shall be air-entrained, air content shall be 3% ± 1% b+ volume.

E. Admixtures to retard or accelerate setting, reduce water ratio or prevent freezing shall not be used without prior approval from Architect.

F. Maximum aggregate size shall conform to the following and shall not exceed tolerances on oversize as per ASTM C-33:

1. Drilled piers, grade beams and foundations: ¾ inch to 1½ inch
2. Slabs on Ground: ¾ inch to 1½ inch
3. Concrete fill: ½ inch

2.03 PRODUCTION:

A. Ready-mixed concrete shall conform to ASTM C-94 and the National Ready Mix Concrete Association. Use of non-agitating trucks is not permitted.

B. All concrete shall be designed for normal rate of hardening. Use of admixtures to retard or accelerate hardening, reduce water ratio or prevent freezing are not permitted without prior written approval of Architect.

C. Use of re-tempered concrete is not permitted.

D. The addition of water at the job site is not permitted, unless authorized by Architect.

E. If air-entrained Portland Cement is used, air-entraining admixtures shall be introduced into the concrete, in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to placing concrete, water, ice, snow, loose dirt and debris shall be removed from the excavation.

B. Fill over excavation to established elevations with concrete fill.

C. Mixing and conveying equipment shall have hardened concrete and other foreign materials removed from inner surfaces before beginning a run of concrete.

3.02 PLACING:

A. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practical by methods which will prevent the separation or loss of the ingredients. It shall be deposited as nearly as possible in its final position to avoid re-handling.

B. Concrete during and immediately after depositing shall be thoroughly vibrated by means of suitable tools. The concrete shall be thoroughly worked around the reinforcement and into the corners of the form.

C. When pouring concrete against previously poured work, the surfaces shall be thoroughly cleaned and roughened, then wetted and coated with a thick cement and water grout, not more than fifteen minutes in advance of the new concrete.

3.03 INTERIOR FLOOR SLABS:

A. Concrete floor slabs on grade shall not be laid until all underfloor construction, including mechanical, plumbing, and electrical lines are installed complete, and backfilled, inspected and approved by the Architect.

1. Floor slabs shall be poured on 4" minimum compacted porous fill. Type of fill and actual depth shall be as recommended by Soils Engineer.

2. Provide vapor barrier with joint tape as required between porous fill and underside of concrete floor slab.

3. Vapor barrier shall be applied over a smooth compacted 4" minimum porous fill base. Vapor barrier shall be lapped a minimum of 6" with lap in direction of concrete pour. Use maximum sheet size with a minimum of joints. Care shall be exercised to prevent damage or rupture of vapor barrier. Where columns, pipe, conduit etc. penetrate membrane, cut around projection and seal with joint tape.

B. Obtain from finish hardware contractor all floor closers, threshold anchors, etc. required to be cast in concrete floor slabs.

C. Concrete floor slab shall be poured in strip or checkerboard pattern in alternate bays. Provide a minimum of three (3) days curing time before intermediate bays are poured.

D. Construction joints unless otherwise indicated on the drawings shall coincide with column center lines.

1. Construction joints shall be keyed.

2. Construction joints as shown on plans.

3. Furnish and install #15 felt bond breaker full depth of slab where slab abuts vertical surface, elsewhere as indicated.

4. Provide #15 felt bond breaker at the perimeter of steel columns.

5. Floor slabs shall be poured in alternate bays.

E. Shape slabs to the slopes and elevations indicated, and accurately pitch or grade to the drainage, fittings, equipment and fixtures occurring therein. Depress and form slabs as indicated on drawings.

3.04 EXTERIOR CONCRETE:

A. Exterior slabs, sidewalks, curbs, pads, ramps, approaches, etc., shall be poured to slopes, elevations and profiles indicated on drawings and accurately pitched to drainage fittings occurring therein.

B. Exterior sidewalks shall be monolithic concrete, reinforced with wire mesh, on 4" minimum sand fill. Slabs at apron shall be a minimum of 6" thick. All other sidewalks and slabs shall be a minimum of 4½ " thick.

C. Furnish and install expansion joints as where slab, sidewalks, etc., abuts vertical surface and not more than fifty feet (50') maximum on center. Joints shall be equally spaced in a regular pattern along sidewalk or within any given slab area. Joints in curb shall align with sidewalk and slab joints.

1. Expansion joints shall be ½" thick, cane fiber conforming to ASTM-1751 full depth of slab. Set filler approximately 1" below finished surface and fill with non-tracking rubber sealant.

a. Control joints in sidewalks shall be spaced as indicated on drawings. Unbroken concrete area shall not be less than 16 square feet and no more than 36 square feet.

b. Control joints shall be 1/8 " - ¼" tooled or formed. Saw cut joint will not be permitted. Depth of joints shall be 1/5 to ¼ of slab thickness.

D. All exposed edges and contractions joints, etc. shall be rounded with a ¼" radius edging tool.

3.05 FINISH:

A. "Definition" of finish types shall be as defined in Specifications for Structural Concrete for Buildings ACI 301.

B. Finished surface of all floor slabs shall be planed to a Class A finish (1/8" in 10'-0" as determined by 10"-0" straight edge placed anywhere on the slab in any direction). All other slabs shall be planed to a Class B finish (¼" in 10'-0" as determined by 10'-0" straight edge placed anywhere on the slab in any direction).

1. Interior floor slabs shall have a "Troweled Finish."

2. Exterior slabs, sidewalks, curbs, pads and ramps shall have a "Broom or Belt Finish."

3. Concrete paving and apron finish shall be "Broom Finish."

3.06 CURING AND PROTECTION:

A. Protect concrete interior and exterior from moisture loss and premature drying for a minimum of 7 days. Follow applicable provisions of ACI 301.

1. Apply liquid curing compound in accordance with manufacturers recommendation.

2. Protect concrete from damage, mechanical injury, load stresses and elements during curing process.

B. Immediately prior to final acceptance apply one (1) coat of floor sealer on all interior exposed concrete.

1. The contractor shall determine that curing compounds, sealers and floor coverings applied to concrete in sequence are compatible.

2. Before using compounds on surfaces which receive additional finishes, obtain approval of the subcontractor applying such finishes.

3.07 REPAIRING, PATCHING, GRINDING:

A. Patch cracks, rock pockets, "Honeycombs," and holes resulting from the removal of the nail rod and cone ties, separators, and core samples. Chip away defective areas to solid concrete, forming perpendicular edges or slightly undercut edges. Drench area of patch and surrounding area with water. Brush a thin coat of cement grout onto the base and edges of the patch area.

B. Concrete floors having floor defects of sufficient magnitude to "read through" the floor covering shall be remedied by grinding, or replacement of concrete slab. No latex underlayment is permitted.

3.08 FIELD QUALITY CONTROL:

A. Field and laboratory test will be required for concrete materials, aggregate slump and concrete strength in accordance with ASTM testing procedures.

3.09 ADJUST AND CLEAN:

A. Concrete or stains of concrete mortar upon any of the adjacent work or upon the ground adjoining the work shall be removed by the Contractor, and the concrete work shall be left clean and in perfect condition.

B. When the work is completed, and at such other times as directed, remove surplus and waste material, debris, rubbish, equipment and implements from the site, and leave the work in a clean, neat and acceptable condition as approved by the Architect.

END OF SECTION

04 22 00

CONCRETE MASONRY UNITS

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. Section includes furnishing and installing unit masonry assemblies, including:
1. Concrete masonry units, including masonry lintels, bond beams, flashings, and related work.
2. Portland cement-lime mortar.
3. Grouted reinforced masonry work as indicated.
4. Cleaning masonry work.

1.3 RELATED WORK

A. Related Work of Other Sections.
1. Division 01 Section – Testing Laboratory Services.
2. Division 03 Section – Cast-in-Place Concrete.
3. Division 05 Section – Structural Steel: Shelf angles and structural supports built into masonry work.
4. Division 05 Section – Metal Fabrications.
5. Division 07 Section – Fluid-Applied Membrane Weather Barriers.
6. Division 07 Section – Building Insulation.
7. Division 07 Section – Joint Sealants.
8. Division 08 Section – Steel Doors and Frames.
9. Division 08 Section – Entrances and Storefront.
10. Division 09 Section – Gypsum Board Systems: Exterior gypsum sheathing.

1.4 REFERENCES

A. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

B. ASTM C90 – Standard Specification for Loadbearing Concrete Masonry Units.

C. ASTM D 1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

1.5 SUBMITTALS

A. Prior to placing orders for Portland cement, provide certified test results showing compliance with requirements, including compliance with the low-alkali requirements.

B. Submit product data for each type of concrete masonry unit and masonry work accessory.

1.6 QUALITY ASSURANCE

A. Pre-Installation Conference: Prior to start of masonry work, meet at Project Site with installer

("Mason"), and representatives of other entities directly concerned with performance of masonry work including test agencies, governing authorities, product manufacturers, Architect, Construction Manager, and Owner.

1. Review requirements (Contract Documents), submittals, status of coordinating work, availability of materials and installation facilities, proposed installation schedule, requirements for inspections and testing, forecasted weather conditions, and proposed installation procedures.
2. Record discussion including agreement or disagreement on matters of significance; furnish copy of recorded discussions to each participant.
3. Discuss masonry protection requirements for construction period extending beyond masonry completion.
4. If meeting ends with substantial disagreements, determine how disagreement will be resolved and set date for reconvened meeting.

1.7 DELIVERY, STORAGE AND HANDLING

A. Store concrete 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.

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 can be maintained and contamination avoided.

1.8 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 covers minimum 24" down both sides of wall and hold securely in place. Where one wythe of multi-wythe masonry is completed in advance of other wythes, secure cover a minimum 24" down face next to unconstructed wythe and hold cover in place.
2. Stain Prevention: Prevent grout, mortar, and soil from staining masonry surfaces exposed to view or scheduled to be painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
3. Cold-Weather Protection Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace masonry damaged by frost or freezing conditions. Comply with cold weather construction requirements as prescribed by codes in force.
4. Hot-Weather Protection Requirements: Protect unit masonry when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade, wind breaks, and use cooled materials as required. When ambient temperature exceeds 100ºF. (38ºC.), or 90ºF. (32ºC.) with a wind greater than 8 mph (12.8-Km/hr), do not spread mortar bed greater than 48" ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete Masonry Units:

1. Lightweight Concrete Masonry Units (CMU-1): ASTM C 90, Lightweight, Type I, moisture controlled units in sizes indicated. Conform to UL requirements at all fire-rated masonry construction. Provide sash block units at control joints and continuous control joint filler.

2. Special Shapes (CMU-04): Provide lintels, bullnose units for outside corners, jambs, control joints, window sill units, solid copings and other conditions indicated. Provide U-shaped lintel blocks with solid bottoms over window and door openings. Provide straight internal corners and straight units at all base locations.

B. Mortar and Grout:
1. Low Alkali Portland Cement: ASTM C 150, low alkali type with not more than 0.60% water-soluble alkali. Provide Type I, except Type III may be used for setting masonry during cold weather. Subject to compliance with requirements, provide TXI Cement Company, New Braunfels, TX, (Tel) 512-396-4244, Type I low alkali Portland cement, or approved equivalent. Do not use masonry cement.
2. Mortar Mix: Provide Portland cement-lime mortar complying with ASTM C 270, Type S mortar mix (1800 psi) for reinforced unit masonry work and Type N mortar mix (750 psi) for veneer masonry. Provide mortar mix consisting of low alkali Portland cement (ASTM C 150, Type I) as specified, lime (ASTM C 207, Type S), clean sand (ASTM C 144, with not less than 100% passing a No. 8 sieve), coloring and water for workable mix. Do not use masonry cement.
   a. Mortar Color: Standard gray Portland cement-lime mortar to match approved sample.

C. Accessories: Provide standard hot-dipped galvanized anchors and accessories for exterior locations and mill galvanized anchors and accessories at interior locations.
1. Anchors:
   a. Types as recommended by masonry manufacturer.
2. Concealed Masonry Flashing: "C-Coat Flashing" by Hohmann & Barnard, Inc., or equivalent by AFCO Products, Polytite Manufacturing Corp., Sandell Manufacturing Co., or York Manufacturing, Inc.
3. Masonry Flashing Drip-Edge: Hohmann & Barnard FTSA Drip Plate, or equivalent.
4. Reinforcing Bars:
   a. Types as recommended by masonry manufacturer.
5. Compressible Filler: Hohmann & Barnard "No. NS," 3/8" thick, or equivalent by Dur-O-Wal.
6. Bond Breakers: Asphalt saturated organic felt, ASTM D 226, Type I, No. 15.
7. Masonry Cleaners: ProSoCo, Inc., Kansas City, MO, "Sure Klean 600" general purpose detergent cleaner, "Sure Klean 101 Lime Solvent" for removal of excess mortar and job stains, and "White Scum Remover" for removal of insoluble salt scums from mortar, or equivalent cleaners formulated to be safe on masonry and non-masonry surfaces such as anodized aluminum, painted surfaces and similar finishes.
8. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, 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; Mortar Net USA, Ltd.; Mortar Net Weep Vents.
9. Drill Screw Fasteners for Screw Attached Masonry Veneer Anchors and Ties: ASTM C 954, except with hex washer head and neoprene washer, No. 10 by length require to penetrate steel stud flange by not less than three exposed threads, and with organic polymer coating complying with ASTM B 117; "Traxx" by ITW-Buildex or "Dril-Flex" by Elco Industries.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 LAYOUT OF MASONRY WORK

A. Layout walls in advance for accurate spacing of surface bond patterns, to provide uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corner, jambs, and wherever possible at other locations.

B. Notify architect of any opening locations that conflict with Concrete Masonry Unit coursing, in either horizontal or vertical dimensions.

3.3 MASONRY INSTALLATION

A. Lay-up exterior concrete masonry unit work in bond indicated in exterior elevations.

B. Laying Masonry General:
1. Lay concrete masonry units making sure head joints and bed joints are full of mortar.
2. Lay concrete masonry units plumb and true to line.
3. Where fresh mortar joins partially set mortar, remove loose concrete masonry unit and mortar and lightly wet the exposed surface of set masonry.
4. When adjustment must be made after mortar begins to harden, remove hardened mortar and replace it with fresh mortar.
5. Remove excess mortar as Work progresses.

C. Masonry Reinforcing and Anchors: Install as indicated and in accordance with the reinforcing manufacturer's requirements.

D. Fabricated Steel Lintels: Install as indicated in Structural Drawings.

E. Control And Expansion Joints:
1. Install control and expansion joints as indicated on Drawings.
2. Keep joints free of mortar and any debris that may hinder movement.
3. Install expansion joint material and finish the joint with a sealer.

F. Cleanouts for Grouting: Provide clean-outs in cells to be grouted at maximum 5- foot centers, vertically. Remove excess mortar by "rodding" and with compressed air. After cleaning cells to be grouted, close clean-outs with masonry to match adjacent construction. Do not place grout until entire height of masonry has attained sufficient strength to resist grout pressure. Place grout in such a way as to prevent segregation of materials. Pour grout fluid enough to flow into all crevices of grout spaces leaving no voids.
1. Cutting and Patching: Provide full size units matching existing adjacent construction for size, texture, bond, and joint profile. Perform repairs so that repaired area is relatively imperceptible in the completed Work.

G. Laying Masonry: Lay masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove in place. Do not slush head joints.

H. Stopping and Resuming Work: In each course, rack back 1/2 unit length for running bond or 1/3 unit length for one-third running bond; do not tooth except at repairs in existing construction. Clean exposed surfaces of set masonry, wet clay masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.

I. Correction of Damaged Masonry: Remove and replace masonry units that are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as required. Provide new units to match adjoining units and install fresh mortar or grout, pointed to eliminate evidence of replacement.

3.4 CLEANING AND PROTECTION

A. Cleaning Concrete Masonry Units: Clean exposed concrete masonry units by dry brushing at

the end of each days work and after final pointing to remove mortar spots and droppings. Comply with NCMA Bulletin No. 28.

B. Protection of Masonry Work: Protect partially completed masonry against weather at the end of each day's work and when work is not in progress, by covering top of walls with strong, waterproof, non-staining membrane. Extend membrane at least 24" down both sides of walls and hold cover securely in place. Protect bases of walls from mud, mortar and other stains. Where cutting, forming, welding and similar operations must be performed near or above masonry work, provide substantial protection against damage.

3.5 FIELD QUALITY CONTROL

A. Test and evaluate each 5,000 sq. ft. or grouted reinforced masonry work, or fraction thereof, as follows:
   1. Mortar Compressive Strength: Provide sampling and testing in accordance with ASTM C 780.
   2. Grout Compressive Strength: Provide sampling and testing in accordance with ASTM C 1019.

B. Evaluation of Quality Control Tests: In the absence of other indications of noncompliance, masonry will be considered satisfactory if results from construction quality control tests comply with minimum requirements indicated.

END OF SECTION

SECTION 05 12 00 STRUCTURAL STEEL

PART 1 GENERAL

1.01 REQUIREMENTS, CODES:

A. All applicable portions of Division 1 - General Requirements are to be considered as included with this section.

B. The following are minimum requirements and shall govern, except that building laws and/or drawings shall govern when their requirements are in excess hereof.

1.02 DESCRIPTION:

A. Provide all materials, accessories, labor, equipment, service, etc., necessary and incidental to the completion of all Structural Steel work as shown on the drawings and as specified herein.

B. Carefully and thoroughly examine the drawings and specifications and provide all items required under this section.

1.03 QUALITY ASSURANCE:

A. This Contractor shall be required to have available at all times, for reference, the latest editions of the following regulations, standards, etc., which are hereby included in and make a part of these specifications.

1. American Institute of Steel Construction Publications: "Manual of Steel Construction - Latest Edition".

B. All welding shall be performed by Welders, Tackers and Welding Operators who have been previously qualified by test as prescribed in the Code for Welding in Building Construction of the American Welding Society.

C. All structural metals shall conform to specified ASTM standards.

D. All high-strength bolts shall be tightened by the "Turn-of-Nut" method as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation and endorsed by the A.I.S.C.

1.04 SUBMITTALS:

A. Submit shop drawings to the Architect for approval. See Division 1 of the Specifications.

1.05 PRODUCT DELIVERY AND STORAGE:

A. The loading, transportation, unloading and storage of structural steel members shall be conducted so that structural steel members will remain clean and free from distortion and deformation.

B. Column leveling plates, anchor bolts and templates shall be shipped in advance of structural steel order. Coordinate with concrete Contractor.

1.06 JOB CONDITIONS:

A. The Contractor shall give his special attention to the handling of steel during construction to avoid overloading green floor slabs.

B. Protect all adjacent finished surfaces during the process of welding. Damaged surfaces shall be replaced at the cost of this Contractor.

C. Steel elevations indicated are established on the basis of a 2½" deep standard joist seat. Adjust column cap and beam elevations as required if joist seat exceeds 2½" depth.

PART 2 PRODUCTS

2.01 MATERIALS:

A. All steel for W-shapes shall conform to ASTM A992, Grade 50.

B. All steel for angles, channels, plates and bars shall conform to ASTM A-36.

C. All steel pipe columns shall conform to ASTM A-53, type E or S, Grade B.

D. All steel for hollow structural sections shall conform to ASTM A-500, grade B.

E. All arc welding electrodes shall be E-70XX series conforming to the requirements of the American Welding Society and AISC Specifications.

F. Steel bolts, nuts, and washers shall be high strength and conform to ASTM A-325. Bolts shall carry the identifying mark of three (3) radial lines.

1. Steel bolts, nuts, and washers conforming to ASTM A-307 may only be used for temporary field connections.

G. Anchor rods shall conform to ASTM F1552, grade 55, weldable.

H. Provide shop coat of paint on all steel items.

1. Shop coat paint shall be zinc chromate, lead chromate or red lead (20# content or equal). It is the intent to permit the use of the fabricator's standard tank or spray bath process.
2. Asphalt based coatings are not permitted.

2.02 FABRICATION:

A. All steel shall be fabricated and connections made in accordance with the AISC "Manual of Steel Construction" Seventh Edition unless otherwise indicated on drawings.

B. All members shall be free from twists, kinks, buckles or open joints. Parts assembled with bolts shall be in close contact, except where separators are required. All members shall be so accurately made, and holes accurately made and spaced, that when assembled, the parts shall come together and bolts enter without distortion.

C. Structural steel shall be provided with all holes, anchors, clips, etc. for attaching wood, masonry, storefront etc.

1. Weld adjustable masonry anchors furnished under Section 4.

D. Bearing surfaces shall be planed to true beads. Abutting surfaces shall be closed fitted.

E. Steel members requiring accurate alignment shall be provided with slotted holes and/or washers for aligning the steel accurately. Provide required architectural clearances.

F. Shop connections shall be welded or bolted, field connections shall be bolted unless otherwise indicated.

G. Beam lintels shall be of a length to provide 8" bearing each side of opening, unless otherwise noted on the drawings.

PART 3 EXECUTION

3.01 PREPARATION:

A. Dimensions shall be verified on the job and full responsibility for the agreement of dimensions with general construction drawings shall be assumed by the Contractor.

3.02 ERECTION:

A. Erection shall include the setting and erection of all structural steel and shall be in accordance with the AISC Manual of Steel Construction, latest edition.

B. Furnish all column leveling plates, anchor bolts and setting templates to Concrete Contractor for installation. Supervise installation to assure proper alignment and location.

C. The frame shall be carried up true and plumb, and temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment, and the operation of same. Such bracing shall be left in place as long as may be required.

D. As erection progresses, the work shall be securely bolted up to take care of all dead load, wind, and erection stresses.

E. Bolted connection shall be made with high strength friction type bolts and hardened washers. Bolts shall be marked before final tightening. Set high strength bolts by the "Turn-of-the-nut" method.

F. Whenever piles of material, erection equipment, or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from same.

G. No final bolting or welding shall be done until each portion of the structure has been properly aligned.

H. Coordinate location of angle frames for HVAC units, exhaust fans, roof hatches, etc., with architectural, mechanical drawings and approved equipment and metal deck shop drawings.

I. Field errors shall not be corrected by burning, except with the permission of the Architect and Owner.

J. Any damaged steel shall be replaced unless directed otherwise by the Architect and Owner.

K. All field bolts, field welds, and serious abrasions to the shop coat shall be spot painted with the same material used for the shop.

3.03 FIELD QUALITY CONTROL:

A. High strength bolted connections shall be tested in conformance with the Specifications for Specifications for Structural Joints using ASTM A-325 or A-490 bolts. See Division 1 of the specifications.

END OF SECTION

SECTION 05 31 00 METAL DECKING

PART 1 GENERAL

1.01 REQUIREMENTS, CODES:

A. All applicable portions of Division 1 - The Contract for Construction, along with General, and Supplementary Conditions of the Contract for Construction are to be considered as included with this section.

B. The following are minimum requirements and shall govern, except that all federal, local and/or state codes and ordinances shall govern when their requirements are in excess hereof.

1.02 SUMMARY

A. This Section includes the following:

1. Roof deck.
2. Canopy deck.
3. Form deck.

1.03 RELATED SECTIONS INCLUDE THE FOLLOWING:

4. Division 3 Section "Cast-in-Place Concrete" for concrete fill.
5. Division 5 Section "Structural Steel" for shop- and field-welded shear connectors.
6. Division 5 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.04 SUBMITTALS

Product Data: For each type of deck, accessory, and product indicated.

A. 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.

B. Welding certificates.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

B. 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."

C. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.06 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

2.01 MANUFACTURERS

D. 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. Steel Deck:

   a. ASC Profiles, Inc.
   b. Canam Steel Corp.;The Canam Manac Group.
   c. Consolidated Systems, Inc.
   d. DACS, Inc.
   e. D-Mac Industries Inc.
   f. Epic Metals Corporation.
   g. Marlyn Steel Decks, Inc.
   h. New Millennium Building Systems, LLC.
   i. Nucor Corp.; Vulcraft Division.
   j. Roof Deck, Inc.
   k. United Steel Deck, Inc.
   l. Valley Joist; Division of EBSCO Industries, Inc.
   m. Verco Manufacturing Co.
   n. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

2.02 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 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.
2. Deck Profile: Type WR, wide rib.
3. Profile Depth: 1-1/2 inches (38 mm).

4. Design Uncoated-Steel Thickness: 0.0295 inch (0.75 mm).
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped.

2.03 CANOPY 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 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.
2. Deck Profile: Type Corrugated.
3. Profile Depth: 1 inch (25 mm).
4. Design Uncoated-Steel Thickness: 0.0295 inch (0.75 mm).
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped.

2.04 FORM DECK

A. Steel Conform Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Non-Composite Form Deck," in SDI Publication No. 30, and with the following:

1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.
7. Deck Profile: Type Conform.
8. Profile Depth: 9/16 inch (15 mm).
9. Design Uncoated-Steel Thickness: 0.0295 inch (0.75 mm).
10. Span Condition: Triple span or more.
11. Side Laps: Overlapped.

2.05 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

E. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
   1) For use with bar joist framing supports with top chord thickness 1/8 in. to 3/8 in.:
      a) Hilti X-EDNK22 THQ12 (1/8 in. up to, but not including 1/4 in.)
      b) Hilti X-EDN19 THQ12 (greater than 3/16 in. up to and including 3/8 in.)
   2) For use with structural steel framing supports with top flange thickness 1/4 in. or thicker:
      a) Hilti X-ENP-19 L15 (1/4 in. or thicker)

F. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.

G. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

H. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.

I. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

J. Galvanizing Repair Paint: ASTM A 780.

PART 3 EXECUTION

3.01 EXAMINATION

K. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.02 INSTALLATION, GENERAL

L. 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.

M. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

N. Locate deck bundles to prevent overloading of supporting members.

O. 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.

P. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

Q. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

R. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

S. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

T. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.03 ROOF-DECK INSTALLATION

U. Install steel roof deck sheets and accessories in accordance with manufacturer's instructions and as shown on the Drawings.

B. Install mechanical fasteners at the spacing and pattern as shown on the Drawings.

C. 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 (450 mm), and as follows:

1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.

D. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:

1. End Joints: Lapped 2 inches (51 mm) minimum.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.

3.04 FIELD QUALITY CONTROL

F. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

G. Field welds will be subject to inspection.

H. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

I. Remove and replace work that does not comply with specified requirements.

J. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 REPAIRS AND PROTECTION

K. 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.

L. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05 40 00 – 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 other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Requirements including but not limited to:
   1. Load bearing wall framing.
   2. Exterior nonload bearing wall framing.
   3. Floor joist framing.
   4. Roof rafter framing.
   5. Ceiling joist framing.
   6. Soffit framing.
   7. Accessories necessary for a complete installation.

1.3 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrications.

B. Section 09 21 16 – Gypsum Board.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, licensed in the State of Texas, 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: Indicated on Structural Drawings.
   2. Coordinate the requirements on the Structural Drawings with the requirements of this Section. If a conflict exists, notations on the Structural Drawings take precedence.
   3. The following document governs the Work, except where more restrictive items are specified:
      AISI Design of Cold-Formed Steel Structural Members Wind Load
      Minimum Design Loads
      1. As required by code officials having jurisdiction.
      2. Deflection: 1/600 for clear simple spans
      3. Deflection: 1/300 for cantilever conditions and roof parapets
      4. Gauge: 18 gauge minimum, unless noted otherwise.

   4. Welding Qualifications: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".
   5. Studs, tracks, channels, and other light gauge framing members shall conform to requirements of ASTM C955.
   6. Fire-Rated Assemblies: Where framing units are components of assemblies indicated for a fire-resistance rating, including those required for compliance with governing regulations, provide units that have been approved by governing authorities that have jurisdiction.
   7. 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 degrees F (67 degrees C).

8. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure:
   a. Upward and downward movement of 1-1/2 inches (38 mm).

9. Design exterior nonload bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold Formed Steel Framing Design Standards:
   1. Floor and Roof Systems: AISI S210.
   2. Wall Studs: AISI S211.
   3. Headers: AISI S212.
   4. Lateral Design: AISI S213.

1.5 SUBMITTALS

A. Product Data: Technical data for cold formed steel framing product and accessories including factory applied primers.

B. Shop Drawings: Submit layout, spacings, sizes, thickness, and types of cold formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
   1. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Supplementary Design Details: The general design is presumed adequate to permit compliance with the specified performance. Provide engineering calculations to supplement the general design. Calculations shall bear the seal of a Registered Professional Engineer, licensed in the State of Texas. Calculations must show design will with stand wind loading commiserate with class and rating of the project.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Welding Qualifications: Qualify procedures and personnel according to the following:
      a. AWS D1.1/D1.1M Structural Welding Code - Steel.
      b. AWS D1.3/D1.3M Structural Welding Code - Sheet Steel.

   2. Comply with AISI North American Specification for the Design of Cold Formed Steel Structural Members and Standard for Cold Formed Steel Framing - General Provisions.
      a. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.
      b. Comply with AISI S230 Standard for Cold Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings.

   3. Fire Resistance Ratings: ASTM E 119; testing by a UL. Identify products with appropriate markings of applicable testing agency. Indicate design designations from UL *Fire Resistance Directory*.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Texas and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold formed metal framing that are similar to those indicated in material, design, and extent.
   1. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and structural data.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cold formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CEMCO; California Expanded Metal Products Co.
   2. ClarkDietrich Building Systems.
   3. Consolidated Fabricators Corp.; Building Products Division.
   4. Marino\WARE.
   5. SCAFCO Corporation.
   6. The Steel Network.

2.2 LOAD BEARING WALL FRAMING

A. Steel Studs: C shaped steel studs, of web depths indicated, punched, with stiffened flanges:
   1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
   2. Flange Width: 1-5/8 inches (41 mm).
   3. Section Properties: Refer to the Drawings.

B. Steel Track: U shaped steel track, of web depths indicated, unpunched, with straight flanges:
   1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
   2. Flange Width: 1-1/4 inches (32 mm).

C. Steel Box or Back to Back Headers: C shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges:
   1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
   2. Flange Width: 1-5/8 inches (41 mm).

D. Steel Single or Double L Headers: L shapes used to form header beams, of web depths indicated:
   1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
   2. Top Flange Width: 1-5/8 inches (41 mm).
   3. Section Properties: Refer to the Drawings.

2.3 EXTERIOR NONLOAD BEARING WALL FRAMING

A. Steel Studs: C shaped steel studs, of web depths indicated, punched, with stiffened flanges:
   1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
   2. Flange Width: 1-5/8 inches (41 mm).
   3. Section Properties: Refer to the Drawings.

B. Steel Track: U shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
2. Flange Width: 1-1/4 inches (32 mm).

C. Vertical Deflection Clips: Head 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. AllSteel & Gypsum Products, Inc.
b. ClarkDietrich Building Systems.
c. Marino\WARE.
d. SCAFCO Corporation.
e. Simpson Strong-Tie Co., Inc.
f. Steel Network, Inc. (The).
g. Steeler, Inc.

D. Single Deflection Track: 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:
1. Minimum Base Metal Thickness: 0.0428 inch (1.09 mm), 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
2. Flange Width: 1 inch (25 mm) plus the design gap for one story structures and 1 inch (25 mm) plus twice the design gap for other applications.

E. Double Deflection Tracks: Double, deep leg, U shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure:
a. Minimum Base Metal Thickness: 0.0428 inch (1.09 mm), 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
b. Flange Width: 1 inch (25 mm) plus the design gap for one story structures and 1 inch (25 mm) plus twice the design gap for other applications.

2. Inner Track: Of web depth indicated:
a. Minimum Base Metal Thickness: 0.0428 inch (1.09 mm), 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
b. Flange Width: 1 inch (25 mm) plus the design gap for one story structures and 1 inch (25 mm) plus twice the design gap for other applications.

F. Drift Clips: Bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.4 SOFFIT FRAMING

A. Exterior Soffit Frame: C shaped steel sections, of web depths indicated, with stiffened flanges:
1. Minimum Base Metal Thickness: 0.0428 inch (1.09 mm)] [0.0538 inch (1.37 mm).
2. Flange Width: 1-5/8 inches (41 mm) minimum.

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 appropriate thickness and configuration, unless otherwise indicated:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole reinforcing plates.
11. Backer plates.

C. Anchors, Clips, and Fasteners:
1. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot dip process according to ASTM A 123/A 123M.
2. 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.
3. 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.
4. Mechanical Fasteners: ASTM C 1513, corrosion resistant coated, self-drilling, self-tapping, steel drill screws.
   a. Head Type: Low profile head beneath sheathing.

5. Welding Electrodes: Comply with AWS standards.

D. Miscellaneous Materials:
1. Galvanizing Repair Paint: SSPC-Paint 20 or ASTM A 780.
2. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage compensating agents, and plasticizing and water reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30 minute working time.
3. 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.
4. Sealer Gaskets: Closed cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from standard widths to match width of bottom track or rim track members.

2.6 FABRICATION

A. Fabricate cold formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI specifications and standards, manufacturer written instructions, and specified requirements.
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.

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 (1:960) and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold formed steel framing assembly to a maximum out of square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

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.

3.2 PREPARATION

A. Before sprayed fire resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire resistive materials, remove only as much as necessary to complete installation of cold formed framing without reducing thickness of fire resistive materials below required thickness to obtain fire resistance rating indicated. Protect remaining fire resistive materials from damage.

C. 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 (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. 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 ERECTION

A. General:
   1. Track Anchors: Install anchors maximum 4 feet - 0 inches on center; design anchors and spacing to carry live, dead and wind loads.
   2. Track Splices: Provide channel inserts or weld track splices.
   3. Erection: Install members plumb, level, and in a true plane.
   4. Fastenings: Make assembly rigid and secure, with welds free of voids and burnouts.

B. Install metal framing systems in accordance with stud manufacturer's printed instructions.

C. Runner Tracks:
   1. Install continuous tracks sized to match studs.
   2. Align tracks accurately to layout at base and tops of studs.
   3. Secure tracks as recommended by stud manufacturer, except do not exceed 24 inches on center for nail or power-driven fasteners, nor 16 inches on center for other types of attachment.
   4. Provide fasteners at corners and ends of tracks.
   5. Tracks shall be anchored to structural steel prior to installing sprayed on insulation.

6. Provide Deflection Track (DT), at top of stud walls at floor or roof above, typically. Allow for 1/2 inch movement of primary structure. Do not attach studs directly to Deflection Track.
7. Vertical Deflection Clips: Provide manufacturer's standard bypass and head clips, capable of accommodating upward and downward vertical displacement of primary structure

D. Secure studs to top track and bottom runner track by means of approved self-drilling screws or welding at both inside and outside flanges of 14 gauge or heavier material. Screws and welds shall be of sufficient size to insure strength of connection. All welding shall comply with American Welding Society "Specification for Welding Sheet Steel in Structures."

E. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.

F. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure. Use Zee clips as specified above. Weld "Z" shaped clips to structural members as shown on drawings. Maximum 2 feet on center vertical.

G. Install supplementary framing, blocking and bracing in the metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with the stud manufacturer's recommendations and industry standards in each case, considering the weight or loading resulting from the item supported.

H. Frame wall openings with extra studs, equal to the number of studs interrupted by wall openings, placed at each side of wall openings. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with shoes or by welding, and space jack studs same as full-height studs of the wall. Secure stud system all around to wall opening frame in the manner indicated.

I. Install bracing/bridging in accordance with manufacturer's instructions and design conditions.

J. Touch up field welds and damaged galvanized coating, except touch up of field cut studs is not required.

K. Frame both sides of expansion and control joints with separate studs; do not bridge the joint with components of stud system.

L. Install horizontal stiffeners in stud system, space (vertical distance) at no more than 54 inches on center. Weld at each intersection.

END OF SECTION 05 40 00

05 50 00

METAL FABRICATIONS

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. Section Includes:
1. Miscellaneous framing and supports for the following:
   a. Louvers.
   b. Lavatory counters.
   c. Metal pan steel stairs and platforms.
   d. Steel pipe handrails.
   e. Steel ladders and supports.
   f. Applications where framing and supports are not specified in other sections.
2. Shelf and relieving angles.
3. Alternating-tread stairs
4. Miscellaneous steel trim.
5. Pipe bollards.
6. Loose bearing and leveling plates.
7. Loose steel lintels.
8. Rough hardware.
9. Heavy duty metal bar gratings and frames for trench drains.
10. Prefabricated metal framing.

B. Products furnished, but not installed, under this Section:
1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Sections:
1. Section 03 30 00 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 04 21 00 "Face Brick" for installing loose lintels, anchor bolts, and other items built into face brick.
3. Section 04 22 10 "Decorative Concrete Masonry" for installing loose lintels, anchor bolts and other items built into decorative concrete masonry.
4. Section 04 70 00 “Cast Stone Masonry” for installing loose lintels, anchor bolts, and other items built into cast stone masonry.
5. Section 05 12 00 "Structural Steel Framing" for structural steel framing including elevator machine support beams, hoist beams, and divider beams.
6. Section 06 10 00 "Rough Carpentry" for metal framing anchors.
7. Section 14 24 00 “Hydraulic Elevators.”

1.3 REFERENCES

A. Comply with the provisions of the following codes, standards and specifications, except as otherwise shown and specified.
   1. AISC: Follow AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings", including "Commentary of the AISC Specifications".
   2. AISI: Follow AISI "Specifications for the Design of Cold-Formed Steel Structural Members".
   3. ASTM: Follow ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".
   4. AWS: Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" and D1.3 "Structural Welding Code – Sheet Steel". Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 PERFORMANCE REQUIREMENTS

A. Fabrication Workmanship: Provide the following classes of workmanship for miscellaneous metal fabrication items indicated or required.
   1. Class 1 Workmanship: Items that are exposed to view in finished spaces in completed Work.
      a. Exposed Surfaces: Sandblast surfaces smooth; grind off mill marks; fill nicks and scratches so that defects do not show when painted. Remove sharp corners and edges.
      b. Welds: Conceal welds where possible. Where exposed, grind welds to small radius with uniform sized cove. When painted, welds shall be undetectable.
      c. Bolts: Use only flat head countersunk bolts in exposed locations.
      d. Straightness: Distortions visible to the eye will be rejected.
      e. Joints: Fit joints to hairline finish.
   2. Class 2 Workmanship: Items that are exposed to view in utility areas of the completed Work.
      a. Exposed Surfaces: Moderate irregularities not visible at 30-feet (9 m) may remain. Mill marks may remain. Remove sharp corners and edges.
      b. Welds: Provide neat welds of uniform size. Remove splatter and protrusions.
      c. Bolts: Use only flat or oval head, countersunk bolts where exposed to view.
      d. Straightness: Minor distortions not exceeding 1/8-inch (3 mm) in 8'-0" (2.4 m) will be permitted.
      e. Joints: Provide maximum gap of 1/16-inch (1.5 mm).
   3. Class 3 Workmanship: Items that are concealed from view in the completed Work.
      a. Exposed Surfaces: Mill finish with surface preparation for galvanizing or priming.
      b. Welds: Grinding not required.
      c. Bolts: Exposed bolts permitted.

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.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Nonslip aggregates and nonslip-aggregate surface finishes.
   2. Prefabricated building columns.
   3. Metal nosings and treads.

4. Paint products.
5. Grout.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.
1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Samples for Verification: For each type and finish of extruded nosing.

D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2, "Structural Welding Code - Aluminum."

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.9 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 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.

PART 2 PRODUCTS

2.1 METALS, GENERAL

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.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Rolled-Steel Floor Plate: ASTM A 786 rolled from plate complying with ASTM A 36 or ASTM A 283, Grade C or D.

C. Steel Tubing: ASTM A 500, cold-formed steel tubing.

D. Steel Pipe: ASTM A 53, standard weight (Schedule 40) unless otherwise indicated.

E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
   1. Size of Channels: 1-5/8 by 1-5/8 inches unless otherwise required for loads supported.
   2. Material: Galvanized steel, ASTM A 653, commercial steel, Type B, with G90 coating; 0.108-inch nominal thickness.

F. Cast Iron: Either gray iron, ASTM A 48, or malleable iron, ASTM A 47, unless otherwise indicated.

2.3 NONFERROUS METALS

A. Aluminum Castings: ASTM B 26, Alloy 443.0-F.

2.4 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 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   1. Provide stainless-steel fasteners for fastening aluminum.
   2. Provide stainless-steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, Property Class 4.6); 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. Eyebolts: ASTM A 489.

F. Machine Screws: ASME B18.6.3.

G. Lag Screws: ASME B18.2.1.

H. Wood Screws: Flat head, ASME B18.6.1.

I. Plain Washers: Round, ASME B18.22.1.

J. Lock Washers: Helical, spring type, ASME B18.21.1.

K. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class and style as required.

L. 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, conducted by a qualified independent testing agency.

M. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

N. 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 (A1) stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594 .
   3. Drilled-in Sleeve Type Expansion Anchors: FS FF-S-325, Group II, Type 3 externally threaded stud with full-length expanding sleeve; Hilti sleeve anchor, or equivalent by Powers or Simpson.
   4. Drilled-in Wedge-Type Expansion Anchors: FS FF-S-325, Group II, Type 4 externally threaded stud with single-piece wedge; Hilti Kwik Bolt II, or equivalent by Powers or Simpson.
   5. Epoxy Adhesive Anchors for Concrete: Hilti Corp., Tulsa, OK, (Tel) 800-879-8000 or 713-462-8699, "HVA Adhesive Anchor", 3/8" x 4" long unless otherwise indicated or required for proper fastening of items indicated, or equivalent by Powers (Rawl), Ramset/Redhead, or Simpson.

O. 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.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Low-Emitting Materials: Paints and coatings 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. Shop Primers: Provide interior exposure primers that comply with Section 09 90 00 "Painting and Coating." and Section 09 96 00 "High-Performance Coatings." For exterior exposure primers.

D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer and compatible with topcoat.
   1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

G. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM

C 1107, specifically recommended by manufacturer for heavy-duty loading applications.

H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

J. Anti-Slip Surfacing: 3M Company "Safety-Walk", black color with adhesive recommended by manufacturer for substrates indicated.

K. Prefabricated Metal Framing and Support Bracing: Equivalent to Unistrut hot-dip galvanized P1000H3 with P3016-1420 nuts, HHCS205075EG hex head cap screws, P1026 ninetydegree angle fittings, (2) P1358 mounting brackets near lower corners of frame, and (4) P2398S beam clamps, unless heavier sections are required to support and brace loads indicated or required by structural calculations. Provide clips of required size for direct attachment to structural steel framing members.

L. Provide cast gratings and frames Type TGMB-10 with form pans as manufactured by McKinley Iron Works, Fort Worth, Texas, or equivalent approved by Architect. Assemble in multiples of stock lengths.

2.6 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 (1 mm) 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.

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 will be 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.
   1. 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 (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.7 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. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports for exterior exposure with primer specified in Section 09 96 00 "High-Performance Coatings".

2.8 SHELF ANGLES

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 (50 mm) larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast in- place concrete.

2.9 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.

2.10 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe, as indicated].

B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts
   1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
   2. Fabricate sleeves for bollard anchorage from steel pipe with 1/4-inch-thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than Outer Diameter of bollard.
   3. Galvanize bollards and sleeves after fabrication.

2.11 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 [zinc-rich primer.] [primer specified in Section 09 Section "High-Performance Coatings."]

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 loose steel lintels located in exterior walls.

2.13 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.14 ROUGH HARDWARE

A. Furnish custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes in the sizes, shapes and dimensions required for framing and supporting and anchoring rough carpentry. Hot-dip galvanize where exposed to atmosphere or embedded into concrete. Furnish malleable iron washers for bolt heads and nuts that bear on wood connections; elsewhere furnish steel washers.

2.15 METAL BAR GRATINGS

A. Provide banded metal bar grating as shown on the Drawings, complying with the NAAMM "Metal Bar Grating Manual" and as specified herein. Furnish grating units complete with angle frames where indicated on the Drawings. Frames and fastening devices shall be of same material and finish as grating supported. Provide removable grating sections with endbearing bars, 4 saddle clip anchors designed to fit over 2 bearing bars, and 4 stud bolts

with washers and nuts. Notching of bearing bars at supports to maintain elevations is not acceptable. Subject to compliance with requirements, provide units produced by Borden Metal Products, IKG Industries or Reliance Steel Products.

1. Furnish grating units complete with angle frames where indicated on the Drawings. Frames and fastening devices shall be of same material and finish as grating supported.
2. Provide removable grating sections with end-bearing bars, 4 saddle clip anchors designed to fit over 2 bearing bars, and 4 stud bolts with washers and nuts. Notching of bearing bars at supports to maintain elevations is not acceptable. Subject to compliance with requirements, provide units produced by Borden Metal Products, IKG Industries or Reliance Steel Products.
3. Pressure-Locked Plain Surfaced Rectangular Steel Bar Grating: Provide I. K. G. Borden Type B pressure-locked grating with 1-1/4” (31 mm) x 3/16” (5 mm) bearing bars at 1-3/16" o.c. and crossbars at 4" (100 mm) on center, or equivalent.
4. Hot-dip galvanize completed assemblies after fabrication.

2.16 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.17 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153 for steel and iron hardware and with ASTM A 123 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, masonry, stonework, unless otherwise indicated.
   1. Shop prime with primers specified in Section 09 painting Sections unless primers specified in Section 09 Section "High-Performance Coatings" are indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 3, "Power Tool Cleaning." requirements indicated below:
   1. Items Indicated to Receive Primers Specified in Section 09 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Other Items: SSPC-SP 3, "Power Tool Cleaning."

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

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

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 operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
   1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Art

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
   1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
   1. Do not fill removable bollards with concrete

B. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.
   1. Embed anchor bolts at least 4 inches (100 mm) in concrete.

C. Anchor bollards in concrete [with pipe sleeves preset and anchored into concrete] [in formed or core-drilled holes not less than 8 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch

toward bollard.

D. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

E. Fill bollards solidly with concrete, mounding top surface to shed water.
   1. Do not fill removable bollards with concrete.

3.4 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Seal thresholds exposed to exterior with elastomeric sealant complying with Division 07 92 00 "Joint Sealants" to provide a watertight installation.

3.5 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of 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 grout.
   1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.

3.6 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 Division 09 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

06 10 00

ROUGH CARPENTRY AND PLYWOOD

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. Section includes furnishing and installing:
1. Dimension Lumber
2. Wood furring, grounds, nailers and blocking.
3. Plywood wall sheathing at areas indicated.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 03 30 00 – Cast-In-Place Concrete.
2. Section 05 50 00 – Metal Fabrications.
3. Section 06 20 00 – Finish Carpentry.
4. Section 07 27 26 – Fluid-Applied Membrane Weather Barriers.
5. Section 07 52 16 – SBS Modified Bitumen Membrane Roofing.
6. Section 07 60 00 – Flashing and Sheet Metal.
7. Section 09 21 16 – Gypsum Board Assemblies for weather resistant gypsum sheathing at all locations other than where plywood wall sheathing is noted.
8. Section 10 28 13 – Toilet Accessories.

1.4 DESIGN/PERFORMANCE REQUIREMENTS

A. Structural Performance
1. Design Wind Load: Refer to Structural General Notes.
2. Roof Loads: Design, fabricate and install roof framing to resist a uniform roof live load of 20-psf and 20-psf dead load.
3. Deflection Limits: Design truss system to withstand design wind, dead and live loads without deflection greater than the following:
a. Roof Framing: Vertical deflection of L/240 of the clear span or 3/4," whichever is less.

1.5 SUBMITTALS

A. Product Data: Submit product data for engineered wood products, underlayment, insulating sheathing, air infiltration barrier, and construction adhesives. Submit product data for each size of metal framing anchors and hurricane anchors indicating load capacity.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that materials comply with requirements.

1.6 QUALITY ASSURANCE

A. Wood Structural Design Standard: Comply with applicable requirements in AFPA's "National Design Specifications for Wood Construction" and its "Supplement.

1.7 ENVIRONMENTAL PERFORMANCE REQUIREMENTS:

A. Provide structural sheathing and underlayment manufactured without a formaldehydebased binding resin or that has a formaldehyde emission below 0.05 ppm.

B. Do not use woods listed by CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), www.cites.org.

C. Preservative treatments shall be waterborne, free of arsenic and chromium.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces.

B. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

PART 2 PRODUCTS

2.1 DIMENSION LUMBER

A. Provide lumber manufactured to comply with DOC PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review. Provide dressed lumber, S4S, air seasoned with maximum 19 percent maximum moisture content, "SDRY," 2-inch or less in nominal thickness. Provide graded and grade-marked lumber as follows, complying with the association grading rules, under whose rules the material was produced. In the event Contractor wishes to use lumber of other species or grades, submit pertinent data for Architect's approval prior to placing orders.
1. Blocking, Furring, Rough Lumber, Joists, Rafters, Headers Beams and Other Horizontal Framing, Not Otherwise Specified: Douglas Fir - Larch No. 2 (WWPA) or Southern Pine No. 2 (SPIB). Preservative treat all plates and other lumber in contact with concrete and roof fascia's.
2. Preservative treat as specified roof curbs and cants; all nailers, blocking, and plates in contact with concrete or masonry; roof edges; wood framing members less than 18" above grade, structural support for decks; and other items indicated.

2.2 CONSTRUCTION PANELS

A. Provide plywood panels complying with DOC PS1 "US Product Standard for Construction and Industrial Plywood" and mat formed or composite panels complying with DOC PS2 "Performance Standards for Wood-based Structural-Use Panels." Factory-mark each panel with APA trademark indicating compliance with grade requirements. Provide the following:
1. Plywood Wall Sheathing: APA RATED SHEATHING, EXTERIOR or EXPOSURE 1, 32/16, minimum 1/2" thick, veneer plywood only.
a. Corrosion-Resistant Insulation Fasteners and Plates for Use with Steel Roof Decks: Provide Johns-Manville, Inc. “UltraFast” hex washer head fasteners with a modified buttress thread form, “X” point tip and blue “ClimaSeal Premium Coating” exceeding the corrosion resistance of FM #4470 for Class 1A Insulated Steel Deck Construction, including I-90 Windstorm Resistance, or equivalent recommended by roof manufacturer in writing. Provide No. 12 fasteners size x length required to penetrate deck by at least 3/4-inch.

2. Exposed Plywood for Equipment Mounting: Exterior type, APA A-C, EXTERIOR, thickness indicated.

2.3 PRESERVATIVE TREATMENT

A. Comply with applicable requirements of AWPA C2 (Lumber) and AWPA C9 (plywood). Provide treatment after members are shaped with waterborne micronized copper quaternary (MCQ), ammonical copper quat-B (ACQ-B), alkaline copper quat-D (ACQD), or copper azole (CA-B) preservative by vacuum pressure full-cell process in accordance with AWPA Standard Specification P-5 and as follows:
   1. Above Ground Use Waterborne Dry Salt Retention: 0.25 lb./cu. ft.
   2. Kiln dry members after treatment to 15% MC. Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
   3. Re-grade and re-stamp lumber after kiln drying in accordance with lumber producer's grading rules.

2.4 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 (3.2 m) beyond the centerline of the burners at any time during the test.
   1. Use treatment that does not promote corrosion of metal fasteners.
   2. 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.

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 qualified testing agency.

E. Application: Treat items indicated on Drawings, and the following:
   1. Framing for raised platforms.
   2. Framing for stages.
   3. Concealed blocking.
   4. Plywood backing panels.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Set rough carpentry work accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
   1. Securely attach carpentry work to substrate by anchoring and fastening as shown and as required by the Nailing Schedule requirements of local codes of authorities having jurisdiction.
   2. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not penetrate members where opposite side will be exposed or covered with finish

materials. Make tight connections between members. Install fasteners without splitting of wood; pre-drilled wood members as required.

3. Do not use materials with defects that might impair quality of rough carpentry or pieces that are too small to use with minimum joints or optimum joint arrangement.
4. Except as otherwise specified, use hot-dip galvanized nails for all exterior work.

B. Plywood: Follow applicable recommendations contained in Form No. E30L, "APA Design/Construction Guide-Residential & Commercial," for plywood product types and applications shown.

1. Wall Sheathing: Provide 1/8" space between long edges of panels and 1/8" space between panel ends. Nail 6" o.c. maximum along panel edges and 12" o.c. maximum along intermediate supports with 10d common nails. For panels subject to high wind loads, nail 4" o.c. along all panel edges and 6" o.c. along intermediate framing with 10d common nails or 8d ring shank nails. Extend sheathing to the lowest point of plate.
2. Roof Sheathing/Insulation: Provide 1/8" space between long edges of panels and 1/8" space between panel ends. Screw fasten 6" o.c. maximum along panel edges and 12" o.c. maximum along intermediate supports with self-drilling corrosion-resistant sheet metal screws to metal roof deck to comply with roof deck performance requirements. For panels subject to high wind loads, screw fasten 4" o.c. along all panel edges and 6" o.c. along intermediate framing with with corrosion-resistant self-drilling sheet metal screws through load dissipating washers. Install two layers of nail base roof insulation with long dimension perpendicular to roof deck and with all joints staggered at least 24-inches from layer below.
3. Use full sheets of sheathing to the greatest extent possible; do not use scraps to fill in areas.
4. Extend wall sheathing to the lowest point of wood framing top and bottom.
5. Provide 1/8" space between long edges of panels and 1/8" space between panel ends. Locate wall sheathing panel long dimension edges over support framing members. Stagger wall and roof sheathing panel end joints from course to course at least 16."

C. Cover sheathing with fluid-applied membrane weather barrier, shingle lapped, and nailed with galvanized roofing nails. Tape all joints and laps with sheathing tape. Repair deteriorated or damaged fluid-applied membrane weather barrier conforming to specified requirements.

END OF SECTION

06 40 00

ARCHITECTURAL WOODWORK

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. Section includes furnishing and installing the following:
1. Plastic laminate clad wood cabinets and cabinet tops.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 06 10 00 – Rough Carpentry.
2. Section 06 20 00 – Finish Carpentry.
3. Section 09 65 00 – Resilient Flooring.
4. Section 09 90 00 – Painting and Coating.
5. Division 22 Sections – Plumbing equipment and systems.
6. Division 26 Sections – Electrical equipment and systems.
7. Division 27 Sections – Communication equipment and systems.

1.4 REFERENCES

A. Referenced Standards: AWI "Architectural Woodwork Quality Standards", 7th Edition, Ver. 1.2, 1999, except comply with more stringent requirements specified.

1.5 SUBMITTALS

A. Submit shop drawings showing location of each item, elevations, and large scale details, indicating related work and complete method of connections, jointing, support, anchorage, reinforcement, material types (including wood species, cut, high pressure decorative laminate grade, finish and color), hardware, and finishes. Show and note field dimensions requiring field measurement for verification and coordination with related work. Submit samples of plastic laminate, each type of hardware, and opaque finished wood.

B. Environmental Submittals:
1. Certification of compliance with the environmental performance requirements specified.
2. Material Safety Data Sheets (MSDS) for adhesive and coatings.
3. Energy performance data.
4. Maintenance data.

1.6 QUALITY ASSURANCE

A. Fabricator/Installer Qualifications: Arrange for work of this Section to be performed by a firm with not less than 3 years successful experience in fabrication and finishing of woodwork similar to required work.

1.7 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.

1.8 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 and relative humidity at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and will maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.

C. 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.

1.9 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. Wood Materials, General: Quality grade, wood specie, cut and match required are specified for each category of architectural woodwork item. Unless otherwise specified, provide lumber and panel products of the grades required by the referenced "Quality Standard" for each quality grade for each woodwork item specified. Where optional materials are indicated within each "Quality Standard" grade, choice is left to fabricator, unless otherwise specified. Particle Board is not acceptable for use on this project and therefore is not indicated below.
   1. Provide materials that comply with requirements of AWI referenced "Quality Standard" for each type of woodwork and quality grade indicated and, where the following products are part of woodwork, with requirements of the referenced product standards, that apply to product characteristics indicated.
      a. Hardboard: AHA A135.4.
      b. High Pressure Decorative Laminate: NEMA LD 3.
      c. Medium Density Fiberboard: ANSI A20
      d. Softwood Plywood: DOC PS-1
      e. Hardwood Plywood and Face Veneers: HPVA HP-1.
      f. Formaldehyde Emissions: Comply with the following:

1) Medium Density Fiberboard: NPA-9.
2) Hardwood Plywood: HPMA FE.

B. High Pressure Decorative Laminate: NEMA LD3 for each exposure and grade required, color as selected; Refer to Finish Legend, elevations and details on the Drawings for product selections, colors, and locations required.

C. Cabinet Hardware and Miscellaneous Item Schedule: All hardware shall meet ANSI A156.9. Refer to Finish Legend on the Drawings for cabinet hinges, pulls, drawer slides and Drawing cabinet elevations for locations required.
1. Catches: Provide opening resistance in compliance with the ADA. Provide top mounted magnetic catch for base and wall cabinet door. Provide two at each tall cabinet door.
2. Adjustable Shelf Supports: Provide dual-pin design with anti-tip-up shelf restraints for both 3/4 inch and 1 inch shelves. Include keel to retard shelf slid-off, and slot for mechanical attachment for shelf to clip. Load rating shall be minimum 300 pounds each support without failure.
3. Wardrobe Rod: Provide 1-1/6-inch diameter plated steel rod, with captive sockets.
4. Coat Hooks: Single or double prong, wall mounted in satin aluminum.
5. Cabinet Locks: Five-disk tumbler cam-style with strike. Locks on cabinets in same room keyed alike unless indicated otherwise in the drawings. Provide two keys per room where doors and drawers are scheduled to receive locks. Provide US26D dull chrome finish. Lock core shall be removable with a control key, permitting Owner to change lock arrangements without tools.
6. Grommets: Provide 2-1/2 inches in diameter with “Flip-Top”™ tab in cap, located where electrical, telephone, and computer data wiring need to pass through tops whether shown or not.
7. Keyboard Drawers: Located at all knee spaces.
8. Pulls: Unless indicated otherwise in drawings, provide 5” wire pulls, with brushed nickel finish.

D. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q, 6 mm thick, unless otherwise indicated.

E. Architectural Cabinets, Laminate Clad: Comply with AWI Section 400 and Division 400B, and AWI "Architectural Casework - General".
1. Laminate Clad Cabinets: "Custom Grade"; flush overlay construction, with any close-grained hardwood listed in the referenced "Quality Standard" for the quality grade specified.
2. Panel product for semi-exposed panel product parts with high pressure decorative laminate shall be same as for exposed surfaces. Provide 1 mm PVC edge banding, matching panel face, at all edges exposed to view.
3. Panel product for exposed panel product parts with high pressure decorative laminate shall be medium density fiberboard plywood, softwood veneer core plywood, or lumbercore plywood listed in the referenced "Quality Standard" for the quality grade specified, except shelves spanning more than 12" shall be veneer or lumber core plywood only.
4. Laminate for Exposed Surfaces and Edges: GP-50 grade.
5. Laminate for Semi-Exposed Surfaces: GP-28 grade.

F. Architectural Cabinet Tops and Cabinet Trim: Comply with AWI Section 400 and Division 400C, and AWI "Architectural Casework - General". Provide the following:
1. Laminate Clad Tops (Laminate Clad Casework Only): "Custom Grade"; with GP- 50 grade laminate at exposed surfaces and edges, BK-50 grade backer sheet at underside of panel core, Interior Type 1M1 medium density fiberboard panel cores,

except at tops where sinks occur, use APA EXT A-C veneer plywood or Exterior Type 2M2 phenolic resin fiberboard. Laminate core to rails, except provide glued-under-pressure lumber drop edge with dado and rabbet continuous lock joint wherever unsupported area of top exceeds 4 sq. ft. Use maximum length laminate with a minimum number of joints. Install laminate on edge first and then on surface. Uniformly bevel edges 15 degrees from edge surface.

2. Solid Surfacing Countertops: See the Finish Legend on the Drawings for product selection, color and thickness required. Provide sub top solid lumber ladder frames to support countertops.

2.2 FABRICATION

A. Comply with AWI "Quality Standards" for lumber moisture content at time of fabrication and for relative humidity conditions in the installation areas.

B. Complete fabrication, assembly, finish hardware application, and other work before shipment to the Project Site to maximum extent possible. Allow for scribing and fitting. Pre-cut openings for related work.

C. Take field measurements for work required to be fitted to other construction.

D. Edge band shelf edges, cabinet door edges and exposed cabinet edges with 3/8-inch hardwood, except where greater depth is required to secure hardware. Use full length pieces only.

E. Apply plastic laminate finish in full uninterrupted sheets consistent with maximum manufactured sizes. Make corners and joints hairline. Locate counter butt joint minimum 2 feet from sink cut-outs. Apply plastic laminate face sheets after application of plastic laminate to edges. Bevel edges 15d from edge surface.

F. Cap exposed plastic laminate edges with material of same finish and pattern.

G. Mechanically fasten splash backs to countertops with steel brackets at 16" o.c. unless shown or noted otherwise.

H. Apply laminate backing sheet to concealed side of plastic laminate finished surfaces.

PART 3 EXECUTION

3.1 PREPARATION

A. Condition woodwork to average prevailing humidity conditions in installation areas prior to installing.

B. Pre-Installation Meeting: Meet at the Project Site prior to delivery of architectural woodwork and review coordination and environmental controls required for proper installation and ambient conditioning in areas to receive work. Include in meeting the Contractor, Architect and City of Houston Representatives (if any), Installers of architectural woodwork, wet work including plastering, other finishes, painting, mechanical work and electrical work, and firms and persons responsible for continued operation (whether temporary or permanent) of HVAC system as required to maintain temperature and humidity conditions. Proceed with woodwork installation only when everyone concerned agrees that required ambient conditions can be maintained.

3.2 EXECUTION

A. Install the work rigid, plumb, level and true with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8 inch in 8'-0" for plumb and level, and with no variations in flushness of adjoining surfaces.

B. Scribe and cut work to fit adjoining work leaving gap of 1/32 inch to adjacent surfaces. Repair or replace damaged finish at cuts. Do not use additional overlay trim for this purpose.

C. Where field cutting or trimming is necessary, perform Work in a neat, accurate, professional manner without damaging woodwork and adjacent Work.

D. Anchor woodwork to anchors or blocking built-in or directly attached to substrates.

E. Counter-sink screw anchorage devices at exposed locations used to wall mount components. Conceal screw fasteners with solid plugs of species to match surrounding wood, grain and color. Finish flush with surrounding surfaces.

F. Cabinets: Install with concealed fasteners, without distortion, so that doors and drawers will fit openings properly, and be accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated. Maintain veneer sequence matching (if any) of cabinets with transparent finish.

G. Tops, General: Anchor securely to base units with concealed fasteners and other support systems as indicated. Join countertop cores with a minimum of 4 wood biscuits arranged to provide flush, tight joints.

H. Repair damaged and defective woodwork and finishes; where possible eliminate functional and visual defects; where repair is not possible, replace item.

I. Refer to Section 09 90 00 for field finishing of exposed opaque finished woodwork.

END OF SECTION

06 80 00

FIBERGLASS REINFORCED PANELING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes furnishing and installing fiberglass reinforced plastic paneling.

B. Related Work of Other Sections:
1. Division 03 Section – Cast-In-Place Concrete.
2. Division 04 Section – Unit Masonry.
3. Division 05 Section – Cold-Formed Metal Framing.
4. Division 05 Section – Metal Fabrications.
5. Division 07 Section – Joint Sealants.
6. Division 07 Section – Sound Batt Insulation
7. Division 08 Section – Hollow Metal Doors and Frames.
8. Division 08 Section – Entrances and Storefront.
9. Division 09 Section – Painting and Coating.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's product literature for each type of Fiberglass Reinforced Panel and accessory required.

B. Shop Drawings: Submit seaming diagrams for the entire work

C. Samples: Submit samples in manufacturer’s standard size of each different type of Fiberglass Reinforced Panel and each different type of accessory as requested by Architect.

D. Product Schedule: Use same designations indicated on Drawings.

E. Maintenance Data: For Fiberglass Reinforced Panels to include in maintenance manuals. Include the following:
1. Methods for maintaining panel system, 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 the fiberglass reinforced panel system.

1.4 QUALITY ASSURANCE

A. Field Measurements: Measure each space to receive fiberglass reinforced paneling, as a basis for supplying, cutting, and seaming the paneling. Do not scale the Architect's drawings or calculate sizes from indicated dimensions.

1.5 SEQUENCING AND SCHEDULING

A. Sequence and schedule installation of Fiberglass Reinforced Paneling with other work to minimize the possibility of damage of Paneling during the remainder of the construction period.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Follow Manufacturer's recommendations for the delivery, storage, and handling of the Fiberglass Reinforced Paneling system(s) used on the project.

B. Fiberglass Reinforced Paneling shall remain in original manufacturer's packaging until such time as it is to be installed.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.

2.2 FIBERGLASS REINFORCED PANELING

A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D 5319.
   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. Crane Composites, Inc.
      b. Glasteel.
      c. Marlite.
      d. Newcourt, Inc.
      e. Nudo Products, Inc.
      f. Parkland Plastics, Inc.
   2. Surface-Burning Characteristics: As follows when tested by a qualified testing agency according to ASTM E 84. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.
   3. Nominal Thickness: Not less than 0.075 inch.
   4. Surface Finish: As chosen by architect from manufacturer's standard range.
      a. Refer to drawings for finish.
   5. Color: As chosen by architect from manufacturer's standard range.
      a. Refer to drawings for color.

2.3 ACCESSORIES

A. Adhesive: As recommended by plastic paneling manufacturer.

B. Sealant: Mildew-resistant, single-component, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Division 07 Section "Joint Sealants."

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 the Work.

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

3.2 PREPARATION

A. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.

B. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.

C. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels unless otherwise indicated.
   1. Mark plumb lines on substrate at panel joint locations for accurate installation.
   2. Locate panel joints to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION

A. Install plastic paneling according to manufacturer's written instructions.

B. Install panels in a full spread of adhesive.

C. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.

D. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION

07 21 00

THERMAL INSULATION

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. Section includes furnishing and installing the following.
1. Glass-fiber blanket insulation within perimeter cold-formed metal framing, soffits and other areas indicated.
2. Foam Board continuous cavity insulation over air barrier at exterior sheathing locations with noncombustible exterior finishes.
3. Rigid cavity non-combustible continuous insulation over air barrier at all other exterior sheathing and other areas indicated.
4. Interior fire rated partition insulation and fire safing.

B. Related Work of Other Sections:
1. Section 04 20 00 "Unit Masonry."
2. Section 05 40 00 "Cold-Formed Metal Framing."
3. Section 07 27 26 “Fluid-Applied Membrane Air Barrier.”
4. Section 07 42 13 “Metal Wall Panels.”
5. Section 07 52 16 “SBS Modified Bitumen Membrane Roofing.”
6. Section 07 62 00 "Sheet Metal Flashing and Trim."
7. Section 07 92 00 "Joint Sealants."
8. Section 08 41 00 "Entrances and Storefronts."
9. Section 09 21 16 "Gypsum Board Assemblies."
10. Section 09 24 00 “Plaster Assemblies.”
11. Section 09 51 00 "Acoustical Ceiling Assemblies."

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

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 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 GLASS-FIBER BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CertainTeed Corporation.
   2. Guardian Building Products, Inc.
   3. Johns Manville.
   4. Knauf Insulation.
   5. Owens Corning.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Blanket Insulation: Unfaced 3-1/2-inch R-11 and 8-inch thick R-25, Greenguard certified fiberglass or mineral wool blanket insulation; CertainTeed CertaPro™ Acousta- Therm™ Batts-Unfaced, Knauf Unfaced Rolls, or Owens-Corning Unfaced Thermal Batt Insulation
   1. Tapes and Sealants: 3M No. 8086 Contractor Sheathing Tape.
   2. Stucco Netting: For support of blanket insulation as indicated.
   3. Wire: Hot-dip galvanized steel wire for support of blanket insulation as indicated.

2.2 FOAM BOARD CONTINUOUS INSULATION

A. Extruded Polystyrene (XPS) Board Insulation: Complies with ASTM C578 with either natural skin or cut cell surfaces.
   1. Type and Compressive Resistance: Type IV, 25 psi (173 kPa), minimum.
   2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
   3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
   4. Type and Thermal Resistance, R-value (RSI-value): Type IV, 5.0 (0.88) per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature.
   5. Complies with fire resistance requirements shown on the drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
   6. Board Edges: Square.
   7. Type and Water Absorption: Type IV, 0.3 percent by volume, maximum, by total immersion.
   8. Manufacturers:
      a. Dow Chemical Company; STYROFOAM HIGHLOAD 40: www.dow.com/#sle.
      b. Kingspan Insulation LLC; GreenGuard XPS TYPE IV 25 PSI: www.trustgreenguard.com/#sle.

c. Kingspan Insulation LLC; GreenGuard XPS TYPE VI 40 PSI: www.trustgreenguard.com/#sle.
d. Owens Corning Corporation; FOAMULAR Extruded Polystyrene (XPS) Insulation: www.ocbuildingspec.com/#sle.
e. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 NON-COMBUSTIBILE CONTINUOUS CAVITY INSULATION

A. Partition and Safing Insulation: ASTM C 612, Class 1A, 1B, and 1VA.
1. Spun mineral wool semi-rigid non-combustible felts, Owens Corning "Thermafiber RainBarrier 45" Fire Safing Insulation or equivalent accepted by Architect.
2. Fire Hazard Classification (ASTM E 84): Non-combustible as defined by NFPA Standard 220
a. Flame Spread: 0.
b. Smoke Developed: 0.
3. Moisture Absorbance (ASTM C 1104): 0.03 percent by volume.

B. Size: Nominal 1-1/2” thickness by 24” width for continuous cavity insulation.

C. Accessories: Provide minimum 0.0538" thick galvanized steel “Impasse Z-Furring Hanger” installation over cold-formed metal framing or manufactures 1-1/2-inch head diameter hot-dip galvanized CMU anchors spaced 16” on center both ways. as recommended by insulation manufacturer to permanently secure insulation in place. Coordinate insulation installation with masonry wall tie installation.

2.4 PARTITION SAFING INSULATION

A. Partition and Safing Insulation: ASTM C 612, Class 1 and 2.
1. Spun mineral wool semi-rigid non-combustible felts, United States Gypsum Company "Thermafiber" Fire Safing Insulation or equivalent accepted by Architect.
2. Fire Hazard Classification (ASTM E 84):
a. Flame Spread: 15.
b. Fuel Contributed: 0.
c. Smoke Developed: 0.

B. Size: Nominal 2” thickness for partition insulation and 4" thickness by depth required for a two-hour fire stop and other penetration conditions indicated.

C. Accessories: Provide minimum 0.0538" thick galvanized steel floor closure plate and minimum 0.016" thick galvanized steel or minimum 0.013" thick stainless steel sheet metal impaling clips as recommended by insulation manufacturer to permanently secure insulation in place.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing vapor retarders, 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.

E. Install insulation below existing roof deck on suspension wires installed as high as possible.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

A. On vertical surfaces, set insulation units tightly laid according to manufacturer's written installation instructions over air barrier and gypsum sheathing: Install CMU drilled in anchors spaced 16 inches o.c. both ways on outside face, and as recommended by insulation manufacturer. Fit courses of insulation horizontally between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

3.4 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

07 27 26

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
1. Continuous fluid-applied, vapor-retarding membrane air-water barrier at all exterior above grade surfaces of backup construction for masonry, stone, metal panels, and similar cladding and veneer finish systems.
2. Air-water barrier transition flashing to adjacent related work to comply performance requirements.

B. Related Sections include the following:
1. Section 03 30 00 "Cast-In-Place Concrete."
2. Section 04 20 00 "Unit Masonry."
3. Section 06 10 00 “Rough Carpentry” for plywood sheathing substrates
4. Section 07 41 13 “Metal Roof Panels.”
5. Section 07 62 00 "Sheet Metal Flashing and Trim."
6. Section 08 41 00 "Entrances and Storefront."

1.3 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.

B. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.5 ACTION SUBMITTALS

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

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

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. (14 sq. m), 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.

B. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.

2.2 PERFORMANCE REQUIREMENTS

A. General: Air barrier shall be capable of performing as a continuous vapor-retarding 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 and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Performance Characteristics:
1. Air Penetration: 0.0002 cfm/ft^2 at 75 Pa, when tested in accordance with ASTM E 2178. Type I per ASTM E 1677 and ≤ 0.01 cfm/ft^2 at 75 Pa, when tested in accordance with ASTM E 2357.
2. Water Vapor Transmission: 25 perms, when tested in accordance with ASTM E 96, Method B at 25 mils DFT (Dry Film Thickness).
3. Water Penetration Resistance: Greater than 1000 cm when tested in accordance with AATCC Test Method 127. No leakage at 15 psf when tested in accordance with ASTM E 331.
4. Air Resistance: Air infiltration greater than 10,000 seconds per 100cc, when tested in accordance with TAPPI Test Method T-460
5. Tensile Strength: Minimum 169 lbs/in^2, when tested in accordance with ASTM D 412.
6. Estimated Elongation: 420% in accordance with ASTM D 412.
7. Hardness: Passes at a Shore A hardness of 71, when tested in accordance with ASTM D 2240.
8. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E 84. Flame Spread: 25, Smoke Developed: 25.
9. Accelerated Weathering: 9 month exposure of membrane to ultraviolet light (UV) in accordance with ASTM G 155.
10. Volatile Organic Content (VOC): Less than 2% when measured in accordance with ASTM C 1250.
11. Adhesion Strength (Concrete): Greater than 33 psi when measured in accordance with ASTM D 4541.

2.3 VAPOR-RETARDING MEMBRANE AIR BARRIER

A. A single-component, low VOC, 25 mil thick synthetic polymer fluid-applied product with superior elasticity and flexibility providing resistance to air flow, bulk water and wind driven rain yet allows moisture vapor to escape.

B. Basis of Design: DuPont™ Tyvek® Fluid Applied WB System; including DuPont™ Tyvek® Fluid Applied WB, DuPont™ Tyvek® Fluid Applied Flashing and Joint Compound, DuPont™ Tyvek® Fluid Applied Flashing – Brush Grade and DuPont™ Sealant for Tyvek® Fluid Applied Systems.

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.

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 fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

G. 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 (75 mm) 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 and Plywood Wall Sheathing: Fill joints greater than 1/4 inch (6 mm) 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.
   1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
   2. Install butyl sealant (at single ply roofing) and modified bituminous (at modified bitumen membrane roofing) strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.

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 roofing-membrane air barrier, 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. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

E. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

F. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply sheet flashing transition strip so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames with not less than 1 inch (25 mm) of full contact.
   1. Adhesive-Coated Flexible Flashing: Roll firmly to enhance adhesion.
   2. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches (150 mm) o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.

G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.

H. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

I. Seal top of through-wall flashings to air barrier with an additional 6-inch- (150-mm-) wide, counter flashing strip.

J. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counter flashings or ending in reglets with termination mastic.

K. 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 (150 mm) 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-Retarding 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, applied in one or more equal coats.

C. Apply strip and transition strip a minimum of 1 inch (25 mm) 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. Termination mastic has been applied on cut edges.
9. Strips and transition strips have been firmly adhered to substrate.
10. Compatible materials have been used.
11. Transitions at changes in direction and structural support at gaps have been provided.
12. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
13. 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 airbarrier 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

07 31 00

SOUND BATT INSULATION

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. Section includes:
1. Glass fiber acoustical blanket Insulation for interior partitions.

B. Related Sections include the following:
1. Section 07 21 00 "Thermal Insulation."
2. Section 09 20 00 "Plaster and Gypsum Board."

1.3 REFERENCES

A. Materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or end use:
1. American Society for Testing of Materials (ASTM):
a. ASTM C423 Test Method for Sound Absorption Coefficient by the Reverberation Room Method.
b. ASTM C518 Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter.
c. ASTM C665 Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
d. ASTM E36 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
e. ASTM E84 Test Method for Surface Burning Characteristics of Building Materials.
f. ASTM E119 Test Methods for Fire Tests of Building Construction and Materials.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.6 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.

1.7 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.

PART 2 PRODUCTS

2.1 FIBERGLASS ACOUSTICAL BATTS (SOUND ATTENUATION BATTS, SAB)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CertainTeed Corporation.
   2. Owens Corning.
   3. Knauf Insulation

B. Unfaced Glass Fiber Acoustical Insulation, complying with ASTM C665, Type I, of varying thicknesses

C. Tapes and Sealants: 3M Vibration Damping Tape

D. Wire: Hot-dip galvanized steel wire for support of blanket insulation as indicated.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing vapor retarders, 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 SOUND ATTENUATION BATTS INSULATION IN CEILINGS

A. 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.

3.4 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

07 54 23

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes furnishing and installing:
1. Adhered thermoplastic polyolefin membrane roofing system over cover board, roof deck insulation over roof deck board over steel roof deck areas indicated.
2. Tapered roof insulation at roof deck sumps, crickets, and reverse slope roof deck areas indicated.
3. Clean-up preparation prior to installation of roof deck insulation, removal and disposal of debris and scraps during and after installation of roof deck insulation.
4. Furnishing and installing sheet metal counter flashings at entire roof perimeter and at all penetrations through roof membrane necessary for the weather integrity of the built-up roof system, as specified in Section 07 62 00.
5. Clean-up, removal of debris and scraps during and after installation of thermoplastic membrane roof system.
6. Coordinate roofing installation with Section 07 72 00 - Roof Accessories.
7. Coordinate plumbing penetrations through roof membrane with work specified in Division 22 Sections.
8. Coordinate HVAC rooftop equipment and penetrations through roof membrane with work specified in Division 23 Sections.
9. Coordinate electrical penetrations and facility lightning protection system installation and penetrations through roof membrane with work specified in Division 26 Sections.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 04 20 00 “Unit Masonry”
2. Section 05 31 00 “Steel Decking.”
3. Section 06 10 00 “Rough Carpentry.”
4. Section 07 62 00 “Sheet Metal Flashing and Trim. Metal counter flashings.”
5. Section 07 72 00 “Roof Accessories.”
6. Section 07 92 00 “Joint Sealants.”
7. Division 21 Sections “Plumbing roof penetrations.”
8. Division 23 Sections “Mechanical roof penetrations.”
9. Division 26 Sections “Electrical roof penetrations.”

1.4 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

B. Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems,"

before multiplication by a safety factor.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane 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. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. Roofing System Design: Provide a 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 7 and comply with UL Class A.
   1. Roof System Design Wind Loads: Provide roof system, including anchorage, capable of withstanding wind-load design pressures calculated according to requirements of authorities having jurisdiction or the American Society of Civil Engineers' ASCE 7, "Minimum Design Loads for Buildings and Other Structures," 6.4.2, "Analytical Procedure," whichever are more stringent.
      a. Basic Wind Speed: 147 mph 3-second gust.
      b. Importance Factor: 1.15
      c. Exposure Category: B.

D. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450. Identify materials with FM Approvals markings and provide roof system components and construction to comply with the following:
   1. Fire/Windstorm Classification: Class 1A-140
   2. Hail Resistance: SH.

E. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

F. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

G. Energy Performance: Provide roofing system with initial solar reflectance not less than 0.77 and emissivity not less than 0.87 when tested according to CRRC-1.

1.6 ACTION SUBMITTALS

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

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   1. Base flashings and membrane terminations.
   2. Tapered insulation, including slopes.
   3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing and fastener spacing’s and patterns for mechanically fastened membrane 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 specified, including T-shaped side and end lap seam.
   2. Roof insulation.

3. Walkway pads or rolls.
4. Metal termination bars.
5. Battens.
6. Six insulation fasteners of each type, length, and finish.
7. Six roof cover fasteners of each type, length, and finish.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified 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: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

D. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.

E. Field quality-control reports.

F. Warranties: Sample of special warranties.

1.8 CLOSEOUT SUBMITTALS

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

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is FM Approvals approved for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

C. Source Limitations: Obtain components including roof insulation, fasteners and other roof system components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer for use in specified roof system.

D. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

E. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.
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. Review deck substrate requirements for conditions and finishes, 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 will affect 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.

F. Preinstallation Roofing Conference: Conduct conference at Project site.
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 will affect 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.

1.10 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.

1.11 PROJECT 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.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period including Severe Hail coverage.

B. Special warranty includes a total roofing system warranty consisting of membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system.

C. Warranty Period: 30 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 THERMOPLASTIC POLYOLEFIN ROOFING

A. Basis of Design: ASTM D 6878, uniform flexible sheet formed from a thermoplastic polyolefin, internally scrim fabric reinforced; Firestone Building Products, Inc., “UltraPly 60-mil TPO XR Platinum Total Roofing System” with wide seam technology adhered over approved roof deck cover board adhered to roof deck insulation adhered to mechanically attached thermal board over steel roof decks.
1. Membrane Flame Spread (UL 790): UL certified Class A.
2. Thickness: 60-mils, nominal.
3. Exposed Face Color: White.
4. Physical Properties:
a. Breaking Strength: 300; ASTM D 751, grab method.
b. Elongation at Break, Minimum: 25-percent; ASTM D 751.
c. Tearing Strength: 55 minimum; ASTM D 751, Procedure B.
d. Field Seam Strength, Minimum lbf/in (ASTM D1876); 40.
e. Brittleness Point: Minus 50-degrees F.
f. Resistance to Heat Aging: Greater than 90 percent minimum retention of breaking strength, elongation at break, and greater than 60 percent tearing strength after 166-hours at 240-degrees F (116-degrees C); ASTM D 573 and ASTM D 751.
g. Linear Dimension Change: Less than 0.1 percent; ASTM D 1204.
h. Accelerated Weathering: Minimum of 24,000 hours without cracking or crazing as tested using ASTM G155.

2.2 AUXILIARY MATERIALS

A. General: Provide only auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing system under terms of the total roof system warranty.

B. Roof Deck Board: USG “Securock” deck board, 4’ by 8’ by 5/8-inch thick.

C. Cold Applied Bonding Adhesive: Manufacturer's standard solvent-free asphalt-modified polyether bonding adhesive for membrane, roof deck insulation, and for base flashings.
1. Liquid-type materials shall meet VOC limits of authorities having jurisdiction.

D. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type,

reinforcement, 60 mil thickness, and color as TPO sheet membrane.

E. Coated Metal: Manufacturer's standard TPO coated metal to receive heat welded TPO membrane.

F. Metal Termination Bars: Manufacturer's standard predrilled stainless steel or aluminum bars, approximately 1-inch by 1/8-inch thick; with anchors.

G. Roof Penetration Curbs (Pitch Pans) and Flashing Sealant: Manufacturer’s standard approved for use with total roofing system as part of the warranty terms.

H. Fasteners (Steel Roof Deck): Factory-coated, self-drilling, wafer head steel fasteners, not less than #3 size, with square drive recess and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate to comply with 90 psf uplift requirements in the field of the roof and 150 psf uplift requirements in perimeter and corners, and acceptable to membrane roofing system manufacturer under terms of the warranty. Provide length to penetrate top flange of steel roof deck by at least three full threads.

I. Expansion Joint Flashings: Manufacturer’s standard factory prefabricated expansion joint flashings and approved for use with total roofing system as part of the warranty terms, in the sizes and configurations required for roof conditions shown. Provide complete with recommended fasteners, factory pre-formed transitions and intersections as required.

J. Miscellaneous Accessories: Provide the following as applicable to roofing systems and conditions shown and to provide complete roofing systems complying with the term of the warranty specified:
1. Pourable sealants
2. Preformed cone flashings
3. Preformed inside and outside corner sheet flashing
4. T-joint covers
5. Seam sealers
6. Termination bars,
7. Reglets
8. Factory coated flashing metal capable of heat welding to roofing membrane
9. Water cut-off mastic
10. Walkway pads
11. Other accessories recommended by the roofing system manufacturer for a complete roofing system installation for the application and system warranty specified.

2.3 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses shown.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1 aluminum foil II, felt or glass-fiber mat facer on both major surfaces as recommended by roofing system manufacturer as part of the total roofing system warranty.
1. Product: Manufacturer’s standard approved for use with total roofing system as part of the warranty terms.
2. Insulation Size, Thickness and Minimum R-Value: Two layers, 4-foot by 4-foot maximum size, in approximately the same thickness, with a combine LTTR (aged) R-value of 23.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4-inch

per 12-inches (1:48), 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.

2.4 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

B. Top Layer, Cover Board (Adhesive Applied Over Roof Deck Insulation): Georgia-Pacific “DensDeck Prime," 5/8-inch thick x 4’W x 4’L, as acceptable to the roof system manufacturer under terms of the roof system warranty terms.

C. Fasteners (Steel Roof Deck Boards): Factory-coated, self-drilling, wafer head steel fasteners, not less than #3 size, with square drive recess and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate to comply with 150 psf uplift requirements in the field of the roof and 225 psf uplift requirements in perimeter and corners, and acceptable to membrane roofing system manufacturer under terms of the warranty. Provide length to penetrate top flange of steel roof deck by at least three full threads.

D. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric mat, water permeable and resistant to ultraviolet degradation, type and weight as recommended by roofing system manufacturer for application, and approved by the roofing system manufacturer as part of the total roofing system warranty terms.

E. Metal Securement System: Perimeter securement flashing and strapping fabricated from stainless steel, a minimum of 0.031-inch thick. Provide fasteners as recommended and approved by the roofing system manufacturer as part of the total roofing system warranty terms.

2.5 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16-inch thick, and as recommended by roofing system manufacturer as part of the total roofing system warranty.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. All mechanical-electrical work to be covered or flashed against has been installed, tested and approved. Work has been completed where possible for all other trades that require work or traffic on the roofing area. Mechanical units are available and ready for installation.
   4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
   5. Verify that poured-in-place concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
7. Verify that lightweight insulating concrete has cured a minimum of 30 days.
8. Proceed with installation only after unsatisfactory conditions have been corrected. Notify Owner's Representative in writing of unacceptable conditions.

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. 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.

3.3 SUBSTRATE BOARD INSTALLATION

A. Steel Decks: Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   1. Fasten substrate board to top flanges of steel deck according to recommendation in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1- 29 for specified Windstorm Resistance Classification, but not less than the following quantity per 4’ by 8’ by 5/8” thick roof substrate board:
      a. Roof Field Zone (Per 4’ x 8’ Sheet): Ten #3 shelf-drilling wafer head fasteners.
      b. Roof Perimeter Zone (Per 4’ x 8’ Sheet): Twenty #3 shelf-drilling wafer head fasteners.
      c. Roof Corner Zone (Per 4’ x 8’ Sheet): Twenty #3 shelf-drilling wafer head fasteners.

3.4 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system 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. 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. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
1. Install insulation layers, maximum 4-feet by 4-feet board size, applied with adhesive, coverage rate as necessary to achieve the specified attachment and uplift rating. Press each board firmly into
2. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place after adhesive develops strings when touched, typically 1-1/2 to 2 minutes after adhesive was applied and roll with a weighted roller. Add temporary weights and use relief cuts to assure that boards are well adhered. Stagger the joints of additional layers by 6-inches in each direction.

3.5 ADHERED ROOFING MEMBRANE INSTALLATION

A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.
1. Install TPO sheet in strict accordance to manufacturers printed instructions and recommendations.

B. Start installation of roofing membrane in presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply bonding adhesive to substrate at rate required by manufacturer and allow to dry until tacky but not stringy or sticky to dry finger touch. Do not apply bonding adhesive to edges of roofing membrane to be het welded.

E. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.

F. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane 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 roofing membrane.
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 membrane that does not meet requirements.

H. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

I. Install roofing membrane and auxiliary materials to tie in to existing roofing.

3.6 BASE FLASHING INSTALLATION

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

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to dry until tacky but not stringy or sticky to dry finger touch. Do not apply bonding

adhesive to edges of roofing membrane to be het welded.

C. Flash penetrations and field-formed inside and outside corners with sheet flashing.

D. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. 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. 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. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect. Notify Architect or Owner 48 hours in advance of date and time of inspection.

C. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do 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.

3.9 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will 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 membrane-roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane-roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean Up: Remove debris, adhesives, and sealant from surfaces. Remove membrane scraps, fasteners, and metal flashing debris and other materials, tools, to provide a neat installation.
   1. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

D. Protection: Installer shall advise Contractor of protection requirements and provide special protection and avoid traffic on completed areas of membrane installation. Restore to original condition or replace work or materials damaged during subsequent construction operation so that upon Final Completion single ply membrane roofing will be without damage.

END OF SECTION

07 62 00

SHEET METAL FLASHING AND TRIM

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. Section Includes:
1. Formed Products:
a. Formed sheet metal roof edge flashings.
b. Formed sheet metal leader boxes.
c. Formed sheet metal downspouts and downspout straps
d. Formed low-slope roof sheet metal fabrications.
e. Formed wall sheet metal fabrications.

B. Related Sections:
1. Section 06 10 00 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 07 54 23 "Thermoplastic Polyolefin Roofing" for installing sheet metal flashing and trim integral with membrane roofing.
3. Section 07 71 00 "Roof Specialties" for manufactured roof specialties not part of sheet metal flashing and trim.
4. Section 07 72 00 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.3 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies as indicated 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. Flashing System Wind Design Loads: Provide roofing system, including anchorage, capable of withstanding wind load design pressures applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
1. Basic Wind Speed: 147 mph 3-second gust.
2. Importance Factor: 1.15
3. Exposure Category: B.

C. 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.4 ACTION 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. Include the following:
1. Identification of material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
4. Details of termination points and assemblies, including fixed points.
5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
7. Details of special conditions.
8. Details of connections to adjoining work.
9. Detail formed flashing and trim at a scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches (300 mm) long and in required profile. Include fasteners and other exposed accessories.
3. Accessories and Miscellaneous Materials: Full-size Sample.
4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified fabricator.

B. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

1. Leader Boxes and Roof Drainage Systems: Chapter 1; Figures 1-25F (Conductor Head), 1-26A (Through Wall Scupper), and 1-27A (Scupper Design).
2. Gutter and Roof Drainage Systems: Chapter 1; Figures 1-5, 1-6 (Exp. Joint), 1-9 (Built-In), 1-17B (Hangers and Brackets), 1-24C (Outlet Tubes), and 1-24D (Leaf Strainers).
3. Downspouts: Chapter 1; Figures 1-32A (Round), 1-35H (Hanger), 4-9, 4-19A, 4- 22A, and 4-22C.
4. Copings: Chapter 3; Figures 3-1, Table 3-1, and 3-4A.
5. Counterflashings: Chapter 4; Figure 4-3A.
6. Roof Penetration Flashings: Chapter 4; Figure 4-13A with fastened and sealed upturned splice as detailed.
7. Roof Vent or Pipe Penetrations: Chapter 4; Figure 4-14C.
8. Thru-Wall Scupper: Chapter 1; Figures 1-26A and 1-26B.

C. Preinstallation Conference: Conduct conference at Project site.
1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
2. Review methods and procedures related to sheet metal flashing and trim.
3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.8 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 the extent necessary for the period of sheet metal flashing and trim installation.

1.9 WARRANTY

A. Special Warranty on Finishes: Manufacturer's standard form in which 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: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755; minimum

0.0179-inch thick.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653, G90 coating designation; structural quality.
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792, Class AZ50 coating designation, Grade 40; structural quality, with smooth surface.
3. Surface: Smooth, flat and mill phosphatized for field painting.
4. Exposed Coil-Coated Surface: Two-coat fluoropolymer complying with AAMA 621 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. Provide color as selected by Architect from manufacturers full-range of available colors.
5. Concealed Coil-Coated Surface: Pretreat with manufacturer's standard white or lightcolored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.2 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBSmodified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
3. Products: Subject to compliance with requirements, provide one of the following:
   a. Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT.
   b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
   c. Henry Company; Blueskin PE200 HT.
   d. Metal-Fab Manufacturing, LLC; MetShield.
   e. Owens Corning; WeatherLock Metal High Temperature Underlayment.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and 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.
   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 Stainless-Steel Sheet: Series 300 stainless steel.

C. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic,

nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

E. 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.

F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

2.4 MANUFACTURED SHEET METAL FLASHING AND TRIM

A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with interlocking counterflashing on exterior face, of same metal as reglet.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Cheney Flashing Company.
      b. Fry Reglet Corporation.
      c. Heckmann Building Products Inc.
      d. Hickman, W. P. Company.
      e. Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
      f. Keystone Flashing Company, Inc.
      g. National Sheet Metal Systems, Inc.
      h. Sandell Manufacturing Company, Inc.
   2. Factory Coated Steel Sheet:, 0.019 inch thick.
   3. Surface-Mounted Type: Provide 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: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
   5. Accessories:
      a. 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 Drawings show reglet without metal counterflashing.
      b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
   6. Finish: Mill.

2.5 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the 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 without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
   4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed 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 (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.

D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.

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. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.

I. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.
   1. Gutter Style: As shown.
   2. Expansion Joints: Butt type with cover plate.
   3. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen.
   4. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
      a. Factory Coated Steel Sheet: 0.016 inch thick.
   5. Gutters with Girth 16 to 20 Inches: Fabricate from the following materials:
      a. Factory Coated Steel Sheet: 0.019 inch thick.
   6. Gutters with Girth 21 to 25 Inches: Fabricate from the following materials:
      a. Factory Coated Steel Sheet:: 0.025 inch thick.

B. Downspouts: Fabricate round downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
   1. Fabricated Hanger Style: SMACNA figure designation 1-35H.
   2. Factory Coated Steel Sheet; 0.016 inch thick.

C. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes. Fabricate from the following materials:
   1. Factory Coated Steel Sheet: 0.016 inch thick.

D. Splash Pans: Fabricate from the following materials:
   1. Factory Coated Steel Sheet:: 0.019 inch thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of both external and internal leg Miter corners, seal, and solder or weld watertight.
   1. Coping Profile: Manufacturers standard complying with specified requirements.
   2. Fabricate from the following materials:
      a. Factory Coated Steel Sheet: 0.050 inch thick.

B. Roof to Wall Transition: Fabricate from the following materials:
   1. Factory Coated Steel Sheet: 0.025 inch thick.

C. Base Flashing: Fabricate from the following materials:
   1. Factory Coated Steel Sheet: 0.019 inch thick.

D. Counterflashing: Fabricate from the following materials:
   1. Factory Coated Steel Sheet: 0.019 inch thick.

E. Flashing Receivers: Fabricate from the following materials:
   1. Factory Coated Steel Sheet: 0.016 inch thick.

F. Roof-Penetration Flashing: Fabricate from the following materials:
   1. Factory Coated Steel Sheet: 0.019 inch thick.

G. Roof-Drain Flashing: Fabricate from the following materials:
   1. Factory Coated Steel Sheet: 0.016 inch thick.

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

3.2 UNDERLAYMENT INSTALLATION

A. General: Install underlayment as indicated on Drawings.

B. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. 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 underlayment within 14 days.

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, solder, welding rods, 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 and levels indicated. 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 (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
   4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
   5. Install sealant tape where indicated.
   6. Torch cutting of sheet metal flashing and trim is not permitted.
   7. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
   1. Coat back side of stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing metal flashing 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.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.

D. Fastener Sizes: Use fasteners of sizes that will penetrate [wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws] [metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance] <Insert size requirement>.

E. Seal joints as shown and as required for watertight construction.
   1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant type joints at temperatures below 40 deg F (4 deg C).
   2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except reduce pretinning where pre-tinned surface would show in completed Work.
   1. Do not solder aluminum sheet.
   2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.4 ROOF DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets spaced not more than 36 inches (900 mm) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
   1. Fasten gutter spacers to front and back of gutter.
   2. Loosely lock straps to front gutter bead and anchor to roof deck.
   3. Anchor and loosely lock back edge of gutter to continuous cleat.
   4. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.
   5. Install continuous gutter screens on gutters with noncorrosive fasteners, removable for cleaning gutters.

C. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints.
   1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
   2. Provide elbows at base of downspout to direct water away from building.

D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in elastomeric sealant compatible with [roofing membrane] <Insert material>.

E. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
   1. Anchor scupper closure trim flange to exterior wall and seal with elastomeric sealant to scupper.
   2. Loosely lock front edge of scupper with conductor head.
   3. Seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.

F. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch below scupper discharge.

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 SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.

C. Copings: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated.
   1. Interlock exterior bottom edges of coping with continuous cleat anchored to substrate at 24-inch (600-mm) in accordance with coping manufacturs complying with performance requirements.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a 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 a minimum of 4 inches and bed with sealant. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant.

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 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Through-Wall Flashing: Installation of through-wall flashing is specified in Division 04 Section "Unit Masonry."

C. Reglets: Installation of reglets is specified in Section 04 20 00 "Unit Masonry."

3.7 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 as indicated 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."

3.8 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.

C. Clean off excess sealants.

D. 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 installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.

E. 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

08 11 00

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes furnishing and installing:
1. Hollow metal doors.
2. Hollow metal frames.
3. Sidelight frames
4. Fire-rated door and frame assemblies.
5. Vision lite frame trim in doors.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Division 04 Section – Unit Masonry
2. Division 04 Section – Exterior Stone Cladding
3. Division 07 Section – Joint Sealants.
4. Division 08 Section – Wood Doors.
5. Division 08 Section – Entrances and Storefront
6. Division 08 Section – Door Hardware.
7. Division 09 Section – Gypsum Board Assemblies.
8. Division 09 Section – Painting and Coating.
9. Division 13 Section – Metal Building Systems.

1.4 SUBMITTALS

A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.

B. Shop Drawings: Show the following:
1. Elevations of each door design.
2. Details of doors including vertical and horizontal edge details.
3. Frame details for each frame type including dimensioned profiles.
4. Details and locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, accessories, joints, and connections.
7. Coordination of glazing frames and stops with glass and glazing requirements.

C. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.

1.5 QUALITY ASSURANCE

A. Steel Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.

B. Fire-Rated Door 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 252.
   1. Test Pressure: Test at positive pressure in accordance with UBC Standard 7-2.
   2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   3. Temperature-Rise Rating: Where indicated, provide doors that have a temperature-rise rating of 450 deg F maximum in 30 minutes of fire exposure.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect. Remove and replace damaged items that cannot be repaired as directed.

C. Store doors and frames at building site under cover. Place units on minimum 4-inch- high wood blocking. Avoid using non-vented plastic or canvas shelters that could create a humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4-inch spaces between stacked doors to permit air circulation.

1.7 SEQUENCING AND SCHEDULING

A. Submit data and schedule at earliest possible date, particularly where acceptance of schedule must precede fabrication of units that must be built into other work. Coordinate door and frame work with door hardware specified in Division 08 Section – Door Hardware.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with Project requirements, provide hollow metal door and frame units produced by one of the following:
   1. Amweld Building Products, Inc. (330) 527-4385.
   2. Curries Co. (515) 423-1334.
   3. Deansteel Manufacturing Co. (210) 226-8271
   4. The Kewanee Corp. (800) 666-4481.
   5. Mesker Door Co. (205) 851-6670.
   6. Premier Products, Inc. (318) 361-0796.
   7. Republic Builders Products (901) 352-3383.

2.2 MATERIALS

A. Steel Sheet, General: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both uncoated steel sheet and the uncoated base metal of metallic-coated steel sheets.

B. Hot-Rolled Steel Sheets: ASTM A 569, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Cold-Rolled Steel Sheets: ASTM A 366, Commercial Steel (CS), or ASTM A 620, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness.

D. Anchors and Accessories: Manufacturer's standard units suitable for type of wall construction, and as follows.
   1. Provide square profile stops with mitered corners for glazing and louvers.
   2. Use galvanized items for units built into exterior walls.
   3. Provide countersunk flat or small oval head Philips or Jackson head fasteners where exposed to view.

E. Primer: Manufacturer's standard rust-inhibitive primer, suitable as a base for specified finish paints.

2.3 DOORS AND FRAMES

A. General: Provide doors of sizes, thicknesses, and designs indicated.

B. Provide the following doors and frames complying with ANSI/SDI A250.8 "Recommended Specifications for Standard Steel Doors and Frames," and as specified.
   1. Exterior Doors: Level 3 and Physical Performance Level A for Extra Heavy Duty, Model 2 doors, "Seamless Design," fabricated with minimum 0.053" thick (old 16 gage) hot-dip galvanized steel faces and edges, insulated "Steel Stiffened Core," with top and bottom flush end closures sealed to eliminate moisture entry into door, and with closer reinforcement.
   2. Interior Doors: Level 2 and Physical Performance Level B for Heavy Duty, Model 2 doors, "Seamless Design" fabricated from minimum 0.042" thick (old 18 gage) steel faces, with "Steel Stiffened Core" and with closer reinforcement.
   3. Exterior Frames: Level 3 and Physical Performance Level A for Extra Heavy Duty frames, fabricated from minimum 0.053" thick (old 16 gage) hot-dip galvanized steel with mitered and continuously seam welded (including rabbets and stop) corners, and with temporary spreader bar at bottom.
   4. Interior Frames: Level 2 and Physical Performance Level B for Heavy Duty frames, fabricated from minimum 0.042" thick (old 18 gage) steel sheet with mitered and continuously seam welded (including rabbets and stop) corners, and with temporary spreader bar at bottom.

2.4 FABRICATION

A. General: Fabricate hollow metal door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

B. Exterior Door Construction: For exterior locations and elsewhere as indicated, fabricate doors, panels, and frames from metallic-coated steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of 0.053- inch- thick (old 16 gage), metallic-coated steel channels with channel webs placed even with top and bottom edges.

C. Interior Door and Panel Faces: Fabricate exposed faces of doors and panels, including stiles and rails of non-flush units, from the following material:
   1. Cold-rolled steel sheet.

D. Core Construction: Manufacturer's standard core construction of the type specified that produces a door complying with SDI standards.

E. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.

F. Clearances for Fire-Rated Doors: As required by NFPA 80.

G. Single Acting, Door-Edge Profile: Square edge, unless beveled edge is indicated.

H. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

I. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.

J. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

K. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.
   1. For concealed overhead door closers, provide space, cutouts, reinforcement, and provisions for fastening in top rail of doors or head of frames, as applicable.

L. Frame Construction: Fabricate frames to shape shown.
   1. For exterior applications, fabricate frames with mitered or coped and continuously welded corners, rabbets, stops, and seamless face joints.
   2. For interior applications, fabricate frames with mitered or coped and continuously welded corners, rabbets, stops, and seamless face joints.
   3. Provide fully welded frames with temporary spreader bars. No open seams are acceptable.
   4. Electrical Knock Out Boxes: Factory weld 18 gauge electrical knock out boxes to frame for electrical hardware preps; included but not limited to electric thru wire hinges, electrical raceways, door position switches, electric strikes, jamb mount card readers, and magnetic 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 3/4-inch knockouts.
      c. Conduit to be coordinated and installed in field from middle hinge box and strike box to door position box.
      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.
      f. Provide field installed conduit per Division 28 section for standardized plug connectors to accommodate up to twelve (12) wires as required for electrified door hardware specified in hardware sets in Division 8 Door Hardware. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Wire nut connections are not acceptable.

M. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for

surface-applied hardware may be done at Project site.

N. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

O. Glazing Stops: Manufacturer's standard, formed from 0.032-inch- thick steel sheet.
   1. Provide non-removable stops on outside of exterior doors and on secure side of interior doors for glass, louvers, and other panels in doors.
   2. Provide screw-applied, removable, glazing stops on inside of glass, louvers, and other panels in doors.

P. Astragals: As required by NFPA 80 to provide fire ratings indicated.

2.5 FINISHES

A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install hollow metal doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.

B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
   1. Except for frames located in existing walls or partitions, place frames before construction of enclosing walls and ceilings.
   2. In concrete construction, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
   3. In metal-stud partitions, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Attach wall anchors to studs with screws.
   4. Install fire-rated frames according to NFPA 80.
   5. For openings 90 inches or more in height, install an additional anchor at hinge and strike jambs.
   6. Seal open seams in exterior units to whatever extent not completed at the factory prior to painting.

C. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.
   1. Fire-Rated Doors: Install within clearances specified in NFPA 80.
   2. Smoke-Control Doors: Install to comply with NFPA 105.

3.2 ADJUSTING AND CLEANING

A. Cleanup: Remove excess weld splatter by grinding flush with adjacent surfaces, without grinding skips or gouging parent metal. Refer to Section 09 90 00 - Paints and Coatings for surface preparation, primer and field applied finish coats.

B. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged

areas of prime coat and apply touch up of compatible air-drying primer.

C. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

08 12 16

INTERIOR ALUMINUM DOORS, FRAMES, AND STOREFRONT SYSTEM

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. Section includes:
1. Aluminum door frames for interior use.
2. Aluminum door frames with sidelight frame components for interior use.
3. Aluminum officefront framing system for interior use.
4. Aluminum and glass doors for interior use.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 08 11 13 – Hollow Metal Doors and Frames.
2. Section 08 14 00 – Wood Doors
3. Section 08 81 00 – Glass Glazing.
4. Section 09 91 00 – Painting and Coating.

1.4 SUBMITTALS

A. Product Data: For each type of door indicated. Include details of core and edge construction, 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.

C. Samples for Verification:
1. Aluminum finish.
2. Assembly of frame with specified glazing included.

D. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Manufacturer shall demonstrate previous experience in manufacturing of interior aluminum door and officefront framing for a period of not less than 10 years on comparable sized project.

B. Source Limitations: Provide aluminum frames, aluminum and glass doors, and accessories produced by a single manufacturer for each type of product indicated.

C. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver frames and doors in cartons to provide protection during transit and storage at project site.

B. Inspect frames and doors upon delivery for damage.
   1. Repair minor damage to pre-finished products by means as recommended by manufacturer
   2. Replace frames and doors that cannot be satisfactorily repaired.

C. Store frames and doors at project site under cover and as near as possible to final installation location. Do not use covering material that will cause discoloration of aluminum finish.

1.7 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.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
   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 Period for Solid-Core Interior Doors: Life of installation.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Basis of Design Product: Raco Interior Products, Classic Series.
   1. 1 ½” frame width x 5 7/16” frame depth.

B. Subject to compliance with requirements, provide products by one of the following
   1. Kawneer
   2. Tubelite
   3. C.R. Laurence Co., Inc.

2.2 MATERIALS

A. Aluminum:
   1. Sheet and Plate: ASTM B 209. Provide alloy and temper recommended by manufacturer for strength, application of required finish, but not less than 22,000- psi ultimate tensile strength.
   2. Extruded Bars, Rods, Shapes and Tubes: ASTM B 221. Provide alloy and temper recommended by manufacturer for strength, application of required finish, but not less than 22,000-psi ultimate tensile strength.
   3. Welding Rods and Bare Electrodes: AWS A 5.10.

B. Steel Materials, General: Fabricate steel reinforcements and supports as follows:
   1. Structural Steel Plates, Shapes, and Bars: ASTM A 36, pickled when exposed to view.
   2. Hot-Rolled Steel Sheet and Strip: ASTM A 570.
   3. Cold-Rolled Steel Sheet and Strip: ASTM A 611.
   4. Stainless Steel Flashing: ASTM A 666, dead-soft, 0.018-inch-thick stainless steel of type selected by manufacturer for compatibility with system.

C. Glazing as specified in Section 08 81 00 – Glass and Glazing.

D. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers; in hardness recommended by manufacturer.

E. Framing system gaskets and joint fillers as recommended by manufacturer for joint type.

F. Sealants: Provide structural sealants recommended by the manufacturer of the storefront system.
   1. Glazing sealants and fillers as specified in Section 08 81 00 – Glass and Glazing.
   2. Structural silicone sealant shall be specifically designed and tested for use as structural sealant.

G. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements, except containing no asbestos, formulated for 30-mil thickness per coat.

2.3 COMPONENTS

A. Interior Door Frames, Borrowed Light Frames, and Storefront Framing:
   1. Fixed Throat with thicknesses indicated on drawings.
   2. Manufacturer’s standard intermediate mullions in widths to match perimeter framing.

B. Swinging Aluminum and Glass Interior Doors:
   1. Medium Stile doors with beveled glazing stops.
      a. Standard stiles and top rails.
      b. ADA compliant, 10” bottom rail.
      c. 6” or Manufacturer’s largest standard midrail (whichever is less) where indicated in drawings.
   2. Hardware per Section 08 71 00 – Door Hardware.

2.4 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.

B. Finish doors at factory.

C. Class II Clear Anodized: AAMA 611 AA--M12C22A31 Class II, minimum thickness .0.4 mil, acid etched, medium matte, clear anodic coating.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine project conditions and verify that project is ready for work of this section to proceed. Do not proceed with installation until unsatisfactory conditions have been

corrected.

B. Verify wall thickness does not exceed manufacturer=s recommended tolerances of specified throat size.

3.2 INSTALLATION

A. Comply with frame and door manufacturer's printed installation instructions and approved shop drawings. Do not attempt installation in areas where wall thickness exceeds tolerances of specified throat size.

B. Install frames plumb and square, free from warp or twist, securely anchored to substrates with fasteners recommended by frame manufacturer. Maintain dimensional tolerances and alignment with adjacent work. Ensure joints are hairline tight and surfaces flush with adjacent components.

C. Set all doors in correct locations as shown on the drawings, level, square, plumb and in alignment with other work in accordance with the manufacturer's installation instructions and approved shop drawings.

D. Install glass in accordance with Section 08 80 00.

3.3 ADJUSTING AND CLEANING

A. Protect exposed portions of aluminum surfaces from damage by plaster, lime, acid, cement, and other contaminants.

B. Touch up marred areas so that touch-up is not visible from a distance of 4 feet. Remove and replace frames that cannot be satisfactorily adjusted.

3.4 PROTECTION

A. Protect as required to assure that frames and doors will be without damage until Substantial Completion.

END OF SECTION

08 14 00

WOOD DOORS

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. Section includes furnishing and installing manufactured flush solid core wood doors with plastic laminate finishes, of the types specified. Factory finishing and fit doors to frames and premachine doors for hardware.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 08 11 13 – Hollow Metal Doors and Frames.
2. Section 08 14 00 – Aluminum Frames.
3. Section 08 81 00 – Glass Glazing.
4. Section 09 91 00 – Painting and Coating.

1.4 PERFORMANCE REQUIREMENTS

A. Provide stiles and rails constructed of two-ply hardwood material providing minimum 1,000 lb. screw withdrawal resistance per ASTM D 143/NWWDA TM-10 (now published by WDMA) and minimum 200,000 slam cycles per ANSI A 151.1/NWWDA TM-7 (now published by WDMA) without failure.

1.5 SUBMITTALS

A. Product Data: For each type of door indicated. Include details of core and edge construction, 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 doors to be factory finished and finish requirements.
4. Indicate fire-protection ratings for fire-rated doors.

C. Samples for Initial Selection: For plastic-laminate door faces.

D. Samples for Verification:
1. Plastic laminate, 6 inches square, for each color, texture, and pattern selected.
2. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.
3. Provide samples for each color, texture, and pattern of plastic laminate required.
4. Frames for light openings, 6 inches long, for each material, type, and finish required.

E. Warranty: Sample of special warranty.

1.6 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 from single manufacturer.

C. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."

D. Fire-Rated Wood Doors: Doors 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 UBC Standard 7-2 or UL 10C.
   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: At vertical exit enclosures and exit passageways, 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.

E. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.8 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.

1.9 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.
   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 Period for Solid-Core Interior Doors: Life of installation.

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.
3. Graham; an ASSA Abloy Group company.
4. Marshfield Door Systems, Inc.
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:
1. Heavy Duty, except as otherwise specified.
2. Extra Heavy Duty: Classrooms, public toilets, janitor's closets, assembly spaces, exits, and similar rough service door locations.

C. Particleboard-Core Doors:
1. Particleboard: ANSI A208.1, Grade LD-1, made with binder containing no ureaformaldehyde resin.
2. Blocking: Provide wood blocking in particleboard-core doors as follows:
a. 5-inch top-rail blocking, in doors indicated to have closers.
b. 5-inch bottom-rail blocking, in exterior doors and doors indicated o have kick, mop, or armor plates.
c. 5-inch midrail blocking, in doors indicated to have exit devices.

D. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

E. Mineral-Core Doors:
1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as follows:
a. 5-inch top-rail blocking.
b. 5-inch bottom-rail blocking, in doors indicated to have protection plates.
c. 5-inch midrail blocking, in doors indicated to have armor plates.
d. 4-1/2-by-10-inch lock blocks
e. 5-inch midrail blocking, in doors indicated to have exit devices.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 PLASTIC-LAMINATE-FACED DOORS

A. Interior Solid-Core Doors:
1. Grade: Premium.
2. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS.
3. Colors, Patterns, and Finishes: As indicated in the Finish Schedule and Finish Legend on the Drawings.

4. Exposed Vertical and Top Edges: Hardwood edges for Impact-resistant polymer edging, applied after faces.
   a. Polymer Edging Color: Same color as faces.
5. Core: Particleboard.
6. Construction: Three plies. Stiles and rails are bonded to core, then entire unit abrasive planed before faces are applied. Faces are bonded to core using a hot press.

2.4 LIGHT FRAMES

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.
   1. Wood Species: Species compatible with door faces and painted to match face.
   2. Profile: Flush rectangular beads.
   3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use. Paint to match door face.

B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

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.
   1. Comply with requirements in NFPA 80 for fire-rated doors.

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.

C. Openings: Cut and trim openings through doors in factory.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 80 00 – Glass and Glazing.

D. Electrical Raceways: Provide raceways for standardized plug connectors to accommodate up to twelve (12) wires as required for electrified door hardware specified in hardware sets in Division 8 Door Hardware. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Wire nut connections are not acceptable.

2.6 SHOP PRIMING

A. Doors for Opaque Finish: Shop prime doors with one coat of door manufacturer's standard wood primer. Seal all four edges, edges of cutouts, and mortises with primer.

2.7 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 top and bottom edges, edges of cutouts, and mortises.

B. Finish doors at factory.

C. Opaque Finish:
   1. Grade: Premium.
   2. Finish: WDMA OP-4 conversion varnish or OP-6 catalyzed polyurethane.
   3. Color: Match door face as approved by Architect.
   4. 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 Section 08 71 00 – Door Hardware.

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
   1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

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

08 43 13

ALUMINUM WINDOWS, STOREFRONTS, AND ENTRANCES

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. Section includes furnishing and installing:
1. Exterior a storefront system, including punched fixed windows, and swing entrance doors.
2. Glass and glazing in conjunction with each of the above components, as specified in Section 08 81 00.
3. Steel supports for storefront systems.
4. Sealants, caulking, joint fillers, gaskets, blocking, and related materials in conjunction with each of the above components and to all adjacent work.
5. Anchors, inserts, reinforcements, support brackets, supplemental internal reinforcement, expansion devices, fasteners, flashings, vents, weeps, and similar elements in conjunction with each of the above components.
6. Cleaning of the work of this Section during construction and final cleaning of the work of this Section.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 05 50 00 – Metal Fabrications.
2. Section 07 27 26 – Fluid-Applied Membrane Air Barriers
3. Section 08 12 16 – Interior Aluminum Doors, Frames, and Storefront System
4. Section 08 44 14 – Glazed Aluminum Curtain Walls
5. Section 08 71 00 – Door Hardware.
6. Section 08 81 00 – Glass and Glazing.

1.4 REFERENCED STANDARDS

A. Comply with applicable standards and specifications published by NAAMM, AAMA, and AA, including definitions of terms and designations not otherwise defined herein.

B. Comply with applicable standards and recommendations by NAAMM, in "Metal Curtain Wall Specifications Manual," "Entrance Manual" and other published specifications and standards, except to the extent more stringent requirements are indicated.

C. Comply with the "Glazing Manual" issued by the Glass Association of North America, latest editions.

D. Aluminum Association (AA) "Standards for Anodically Coated Aluminum Alloys for Architectural Applications."

E. Aluminum Association "Standards for Aluminum Mill Products."

F. National Association of Architectural Metal Manufacturers (NAAMM) "Metal Finishes Manual."

1.5 DESIGN/PERFORMANCE REQUIREMENTS

A. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
1. Structural loads.
2. Thermal movements.
3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
4. Dimensional tolerances of building frame and other adjacent construction.
5. Failure includes the following:
a. Deflection exceeding specified limits.
b. Thermal stresses transferred to building structure.
c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
d. Glazing-to-glazing contact.
e. Noise or vibration created by wind and thermal and structural movements.
f. Loosening or weakening of fasteners, attachments, and other components.
g. Sealant failure.
h. Failure of operating units to function properly.

B. Structural Loads: Framing member sizes and wall thickness indicated are minimums and are for detailing only. Confirm framing member sizes, wall thicknesses, and need for internal reinforcements by analyzing Project loads and in-service conditions. Provide glazed wall system framing member sizes as indicated, but not less than size and strengths required to meet or exceed the following criteria:
1. System Design: Provide entrances and storefront, including anchorage, capable of withstanding windload design pressures applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
a. Surface Roughness Category: Exposure B
b. Classification of Building: Category II
c. Wind Basic Design Load: 147 mph @ 3second gust
d. Safety factor: 1.15
e. ASCE-7 Calculations: Refer to Structural General Notes on the Drawings.
f. Internal Pressure Coefficient: Indicate in the design calculations the internal pressure coefficient used in the design of exterior cladding and components.
2. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.

C. 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 less than 10 seconds.

D. 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.

E. 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 6.24 lbf/sq. ft.

F. 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.

G. 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 windload design pressure, but not less than 6.24 lbf/sq. ft.
   1. Maximum Water Leakage: According to AAMA 501.1. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

1.6 SUBMITTALS

A. Product Data for each product specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.

B. Shop Drawings showing fabrication and installation of entrance and storefront system including plans, elevations, sections, details of components, and attachments to other units of Work. Include metal and glass thickness, details of all field connections and anchorage, fastening and sealing methods, metal finishes, location of all joints, direction of expansion of wall and related components, exposed fasteners, work to be performed by other trades which adjoins and/or is secured to storefront system components, and all other pertinent information.
   1. For installed products indicated to comply with certain design loadings, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Include certification signed and sealed by the qualified professional engineer responsible for the structural analysis preparation that the storefront system design complies with the Design/Performance Requirements specified. Submit engineering calculations and certification with first submittal of shop drawings.
   2. Show full and complete details of the entire system, related construction, general layout and elevations, glazing system, and setting blocks, connections, shims, glass types and sealant types.
   3. Show sequence of erection. Accommodate deviation and qualification to the erection sequence by General Contractor without altering the design profiles.
   4. Do not change shop drawings and data bearing Architect's final review stamp, or deviate from construction operations, unless changes and deviations are coordinated with glass manufacturer and submitted to Architect for review.
   5. Begin fabrication only after receiving shop drawings bearing Architect's final review stamp.

C. Samples for verification of each type of exposed finish required in manufacturer's standard sizes. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.

D. Product test reports from a qualified independent testing agency evidencing compliance of storefront system with requirements based on comprehensive testing of manufacturer's current system.

E. Maintenance Manuals: Submit 3 copies each of detailed procedures for the periodic inspection, maintenance, and cleaning of all applicable storefront system elements, including glass and metal finishes.

F. F. As-Built Drawings: Prior to final acceptance of the work under this Section, transmit 2 "as-built" reproducible copies of all shop drawings and engineering calculations to General Contractor for the permanent Project file. Show all components as actually fabricated and erected.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: To qualify for approval, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of storefront systems that are similar to those indicated for this Project in material, design, and extent.

C. Installer Qualifications: Engage an experienced installer to assume engineering responsibility and perform work of this Section who has specialized in installing storefront systems similar to those required for this Project and who is acceptable to manufacturer.
   1. Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for storefront systems, including drawings, testing program development, test-result interpretation, and comprehensive engineering analysis that shows systems' compliance with specified requirements.
   2. Examine and study the Drawings and Specifications to insure the work as described is complete and submit written notification to the General Contractor of all discrepancies. Direct requests for clarification of conditions from the Installer shall be sent to the General Contractor.
   3. Examine and study the Drawings and Specifications with regard to the surfaces and structural framing to which all applicable work in this Section is attached and anchored. Submit written notification to the General Contractor of all deficiencies and detrimental factors that would affect proper and timely installation of the work of this Section. Furnish and install supplementary parts to comply with design/performance requirements and complete the work indicated. Design and size framing sections and components to meet the design/performance requirements. Furnish and install clips and bracing for secure anchorage of the storefront system elements to the structure.
   4. Coordinate and verify, by measurement at the Project Site, all dimensions affecting work of this Section. Bring field dimensions that are at variance with those on the approved shop drawings to the attention of the General Contractor. Obtain decisions regarding corrective measures from the General Contractor before the start of installation of affected items. Assure compatibility of adjacent items in relationship to work of this Section.

5. Cooperate with the General Contractor in the coordination and scheduling of the work of this Section with the work of other Sections so as not to delay Job progress.
6. Maintain design concept as shown (member sizes, basic profiles, and component alignment). Modify only as necessary to meet performance requirements.

D. Source Limitations: Obtain each type of storefront system from one source and by a single manufacturer.

E. Product Options: Drawings indicate size, profiles, and dimensional requirements of entrance and storefront systems and are based on the specific system indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 01 Section “Product Requirements” for substitution procedures.
1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval and only to the extent needed to comply with performance requirements. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Meetings." Review methods and procedures related to storefront system including, but not limited to, the following:
1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
2. Review structural loading limitations.
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. Review required inspecting, testing, and certifying procedures.
5. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.

1.8 DELIVERY AND STORAGE OF MATERIALS

A. Store materials delivered to the Site in space(s) provided by the General Contractor on each floor of the building to permit easy access to and handling of the materials. Store materials neatly, properly stacked on dunnage, and protected from warping and damage. The Contractor shall not be required to move them except for installation.
1. Transport, handle, and store materials and components in a manner to preclude damage.
2. Deliver accessory materials in manufacturer's labeled containers.
3. Exercise care in handling and protect all materials and finishes during fabrication, shipment, storage, and erection as necessary to prevent damage to the finished surfaces.
4. Remove all units and components that are cracked, bent, chipped, scratched, or otherwise unsuitable for installation and replace with new, approved items.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions.

1.10 WARRANTY

A. Provide special project warranty as specified, agreeing to remove and replace entrance and storefront system work, including but not limited to, aluminum entrance units, storefront framing systems, and glass and glazing work which becomes unserviceable or objectionable in appearance due to failure in materials or workmanship. Warranty includes removal and replacement of related work that must be removed to properly repair or replace storefront system work.
   1. Failure of materials and workmanship includes, but is not limited to, excessive leakage or air infiltration, excessive deflections, deterioration of finish of metal in excess of normal weathering, and defects in hardware and accessories, weatherstripping, sealants, deterioration of glass coating, glass breakage resulting from thermal conditions, deterioration of insulating glass unit edge seal and other components of the work. Failure of materials or workmanship of entrance units includes failures in operation of doors and hardware.
   2. Warranty period shall be 5-years for storefront system work from the Date of Substantial Completion.

PART 2 PRODUCTS

2.1 PRODUCT AND MANUFACTURER

A. Exterior Glazed Storefront System:
   1. Basis of Design: Subject to compliance with Design/Performance Requirements, provide “Trifab AB601 Series” Outside Set, Thermally Broken Storefront” by Kawneer, or equivalent by Oldcastle, Acadia, Traco, Tubelite, American Products Incorporated (API), or Wausau Metal as approved by Architect.
      a. 6" x 2" tube type system complying with Design/Performance Requirements, and with continuous sill pan with end dams below all sills.

B. Medium Stile Entrance Doors:
   1. Basis of Design: Subject to compliance with Design/Performance Requirements, provide Kawneer Medium Stile Doors, or equivalent by Oldcastle, Acadia, Traco, Tubelite, American Products Incorporated (API), or Wausau Metal as approved by Architect.
      a. Frames integral to storefront system
      b. Standard stiles and top rails.
      c. ADA compliant, 10” bottom rail.
      d. 6” or Manufacturer’s largest standard midrail (whichever is less) where indicated in drawings.
   2. Hardware for Medium Stile Entrance Doors:
      a. Continuous Geared Hinges, (1 per leaf).
      b. Thresholds of type required to meet ADA requirements based on sill conditions of doors.
      c. Power transfers:
         1) Electric Power Transfer Hinges are prohibited from use at entrance doors.
         2) Armored Loops may be used provided all parts of the power transfers are concealed from view when the door is closed.
      d. Remainder of Hardware per section 08 71 00 – Door Hardware

2.2 MATERIALS

A. Aluminum:
   1. Sheet and Plate: ASTM B 209. Provide alloy and temper recommended by manufacturer for strength, application of required finish, but not less than 22,000- psi ultimate tensile strength.

2. Extruded Bars, Rods, Shapes and Tubes: ASTM B 221. Provide alloy and temper recommended by manufacturer for strength, application of required finish, but not less than 22,000-psi ultimate tensile strength.
3. Welding Rods and Bare Electrodes: AWS A 5.10.

B. Steel Materials, General: Fabricate steel reinforcements and supports as follows:
1. Structural Steel Plates, Shapes, and Bars: ASTM A 36, pickled when exposed to view.
2. Hot-Rolled Steel Sheet and Strip: ASTM A 570.
3. Cold-Rolled Steel Sheet and Strip: ASTM A 611.
4. Stainless Steel Flashing: ASTM A 666, dead-soft, 0.018-inch-thick stainless steel of type selected by manufacturer for compatibility with system.

C. Glazing as specified in Section 08 81 00 – Glass and Glazing.

D. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers; in hardness recommended by manufacturer.

E. Framing system gaskets and joint fillers as recommended by manufacturer for joint type.

F. Sealants: Provide structural and weatherseal sealants recommended by the manufacturer of the structural sealant storefront system.
1. Glazing sealants and fillers as specified in Section 08 81 00 – Glass and Glazing.
2. Structural silicone sealant shall be specifically designed and tested for use as structural sealant.
3. Secondary seal or weatherseal silicone sealants shall be compatible with the structural silicone sealant. Weatherseal shall accommodate a 50 percent increase or decrease of joint width as measured

G. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements, except containing no asbestos, formulated for 30-mil thickness per coat.

2.3 COMPONENTS

A. Inserts, Brackets and Reinforcements: Provide manufacturers standard high strength aluminum brackets and reinforcements where possible. Where steel units are required for inserts, higher strength or other reason, hot-dip galvanize the units after fabrication, with 2.0 oz. zinc coating, complying with ASTM A 123.

B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials. Finish exposed portions to match glazed aluminum curtain wall.
1. Provide fasteners and accessories complying with the "Design/Performance Requirements." Provide self-locking fasteners and nuts with nylon inserts or patches as manufactured by USM Corporation, Nylok Fastener Division, or equivalent approved by Architect.
2. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
3. Where fasteners anchor into aluminum less than 0.125-inch thick, provide reinforcement to receive fastener threads.
4. Use exposed fasteners with countersunk Phillips screw heads finished to match framing members, unless otherwise indicated.

C. Anchors: 3-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer. Provide hot-dip galvanized steel expansion anchors inserts complying with

ASTM A 123 or ASTM A 153 requirements.

D. Concealed Fasteners: Provide aluminum, 300 Series stainless steel or other noncorrosive metal fasteners of types proven to be compatible with the materials and items being fastened and required to

E. Exposed Fasteners: Provide Phillips countersunk flat-head screws where exposed, unless otherwise approved or required. Finish exposed fasteners to match finish of exposed aluminum in which they occur.

F. Shims: Provide galvanized steel (ASTM A 36 or A 283) and 300 Series stainless steel as approved by the Architect. Use aluminum or plastic shims only as approved by the Architect.

G. Thermal Break: Provide rigid polyvinyl chloride (PVC) extrusions as required to conform to the structural performance requirements as indicated on the Drawings and specified in the "Design/Performance" paragraph.

2.4 FABRICATION

A. General: Fabricate storefront system according to Shop Drawings. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

B. Forming: Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.

C. Prepare components to receive concealed fasteners and anchor and connection devices.

D. Fabricate components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.

E. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld before finishing components. 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.

F. Glazing Pockets: Provide minimum clearances for thickness and type of glass indicated according to GANA’s "Glazing Manual."

G. Metal Protection: 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. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

2.5 ALUMINUM FINISH

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.

B. Exposed Panel Finish - High-Performance Organic Finish (2-Coat Fluoropolymer): AAC12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare,

pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 and with coating and resin manufacturers' written instructions.
1. Color: As selected by Architect from manufacturer's full range. Refer to drawings for general color requirements.

2.6 METAL PRIMING

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying primer.

B. Surface Preparation: Perform manufacturer's standard cleaning operations to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel.

C. Priming: Apply manufacturer's standard corrosion-resistant primer immediately after surface preparation and pretreatment.
1. Paint for Carbon Steel:
a. Concealed Parts: One shop coat of rust inhibitive primer or zinc chromate primer; FS TT-P-645.
b. Exposed Parts: One shop coat of zinc rich paint; MIL-P-2103S and MIL-P-38336.
2. Galvanizing of Carbon Steel:
a. Steel Sheets: FA QQ-S-775c.
b. Hot-dipped for Shapes, Plates, Bars, and Strip: ASTM A 123.
3. Aluminum (Concealed Parts): One shop coat of zinc chromate primer; FS TT-P-645.
4. Dielectric Paint Between Dissimilar Metals: One coat of bituminous paint; FS TTC-494 or MIL-P-6883A.

2.7 SEALANTS

A. One-Part Non-Acid Curing Silicone Sealant: ASTM C 920, Type S, Grade NS, Class 25, and Uses NT, M, G, A, and, as applicable to joint substrates indicated, O; medium modulus with a tensile strength between 45-psi and 75-psi at 100% elongation when tested after 14 days at 77°F and 50% relative humidity per ASTM D 412.
1. Products: Subject to compliance with requirements, provide either General Electric "Silpruf 2000" or Dow Corning "795 Building Construction Sealant."
2. Locations: All metal-to-metal and metal to glass dynamically moving joint locations not otherwise noted or specified, including interior sealant joints on interior side of components subject to thermal movement from exterior heat sources.
3. Colors: As selected by Architect from manufacturer's standard colors.

B. Narrow joint sealant conforming to AAMA Standard 803.3.
1. Tremco "Curtain Wall Sealant" conforming to AAMA Standard 809.2.

C. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by the sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

D. Joint Sealant Backing:
1. Closed-cell polyethylene foam rod, non-gassing.
2. Expanding foam sealant; Polytite B by Polytite Manufacturing Corp. or Polyseal by Sandell Mfg. Co.

2.8 MISCELLANEOUS MATERIALS

A. Self-Adhesive Elastic Flashing: Protecto Wrap Co. "Ice & Water Guard" flashing tape, W. R. Grace "Perm-A-Barrier," Polyguard Products "Polyguard 650," Henry “Blueskin WP 200," or equivalent 40 mil thick rubberized asphalt self-adhesive tape. Include recommended primers.

2.9 FABRICATION

A. General: Complete the cutting, fitting, forming, drilling, and grinding of all metal work prior to cleaning, finishing, treatment, and application of coatings. Conceal fasteners wherever possible. Fabricate and assemble components in accordance with approved shop drawings. Deviations of any nature will not be permitted without prior approval of the Architect. Minor adjustments for weather integrity or strength may be suggested for Architect's approval. In the event of controversies over design or details, the decision of the Architect will take precedence.

B. Carefully fabricate components and assemble with proper and approved provision for thermal expansion and contraction, material and fabrication and installation tolerances, and adjoining building component tolerances and design criteria.

C. Weld aluminum by methods and with materials recommended by the aluminum manufacturer and AWS to avoid distortion and discoloration at welds. Grind exposed welds smooth and restore mechanical finish. Remove arises from cut edges and ease edges and corners to a radius of approximately 1/64-inch.
   1. Where weld metal must be exposed before anodizing, select filler alloys to closely match the composition of the base metal. Follow parent metal manufacturer's recommendations for such filler alloys.
   2. Where concealed weldments are to be made on materials that have been previously anodized or paint coated, remove anodizing or paint film in the area of fusion prior to welding. Mask parts at weld areas during anodizing or sand clean prior to welding. Crazing or discoloring of the anodizing or paint coating on the exposed areas will not be acceptable.

D. Fit and assemble the work at the shop to the greatest extent possible. Disassemble only as required for shipment and erection. Maintain true continuity of line and accurate relation of planes and angles. Provide secure attachment and support at mechanical joints, with hairline fit of contacting members.

E. Where 2 or more sections of metal are used in building up members, bring contact surfaces to a smooth, true, and even surface and secured together so that the joints will be weathertight without the use of pointing material. Exposed sealants, except where shown, will not be permitted. Tolerance extrusions to eliminate edge projection and misalignment at joints.

F. Fasteners: Provide stainless steel fasteners with self-locking devices, unless otherwise noted, and of sufficient size and strength to withstand the applicable design wind load and dead load forces with safety allowance factors as required for the specific materials.
   1. Space fasteners to develop the maximum strength of the members they secure or support.
   2. Provide washers and other accessory items of the same material as the fastener.
   3. Torque-tighten all assembly fasteners (except as may be required at expansion joints) to achieve the maximum torque-tension relationship in the fastener.
   4. At expansion joints, torque-tighten fasteners so as to provide proper support of the expansion joint connection elements and free noiseless movement at the connection without rattling.

G. Conceal fasteners unless otherwise shown or approved. Where exposed fasteners are required, provide countersunk Phillips oval head type, unless otherwise indicated. Finish exposed fasteners to match surrounding metal finish.

H. Provide extruded aluminum removable members, such as glass stops, securely engaged into adjacent components as indicated.

I. Exposed Cladding, Trim, Panels, and Similar Components:
   1. Fabricate cladding elements with fabricated edge flanges as indicated and conforming to the flatness requirements specified. Provide backside stiffener members to maintain required flatness and structural performance.
   2. Do not exceed the following surface slope at any point, when measured at room temperature, measured from the nominal plane of the surface in its final installed position:
      a. 1.0 deg. for surfaces having a finish of high reflectivity.
      b. 1.25 deg. for surfaces having a finish of medium reflectivity.
      c. 1.5 deg. for surfaces having a finish of low reflectivity.

J. Use certified welders and make structural steel welds to conform to the requirements of the American Welding Society Specifications D1.1 "Structural Welding Code - Steel."
   1. Remove dirt, grease, lubricant, and organic materials by vapor or solvent degreasing.
   2. Repair joints rejected because of welding defects only by re- welding. Remove defective welds by chipping or machining. Do not flame cut welds.
   3. Where welding is done in proximity to glass or finished surfaces, protect glass and finished surfaces from damage due to weld sparks, spatter, or tramp metal.
   4. Touch up paint welds in galvanized metal with zinc rich paint.
   5. Fill pinholes in welds and surface damage on all exposed surfaces of work visible under finished lighting condition when viewed from a distance of 6', with 2 component automotive body filler compatible with primer paint. Match adjacent metal surface finish unless otherwise indicated.

2.10 SHOP PAINTING WALL SYSTEM SUPPORT FRAMING

A. Remove scale, rust, and other deleterious materials before the shop coat of paint is applied. Clean off heavy rust and loose mill scale in accordance with SSPC SP-2 "Hand Tool Cleaning." Remove oil, grease and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning."

B. Apply 1 shop coat of primer paint to fabricated support framing, except apply 2 coats of paint to surfaces that are inaccessible after assembly or erection. Change color of second coat.

C. Brush or spray on metal primer paint, at a rate to produce a uniform dry film thickness of 2.0-mils for each coat. Provide full coverage of joints, corners, edges, and all exposed surfaces.

2.11 FABRICATION QUALITY CONTROL

A. Provide full access to Architect, Owner, General Contractor, and their authorized representatives to plants, shops, and assembly points to view and inspect the processes and methods employed in the fabrication, finishing, pre-assembling, and glazing (as applicable) of the storefront system components for this Project.

B. Provide work true to detail with sharp, clean profiles straight and free from defects, dents, marks, indentations, waves, or flaws of any nature impairing strength or appearance, fitted with proper joints and intersections and with specified finishes.

C. All items the Architect's, Owner's, or General Contractor's authorized representative notes to

have any deficiency shall:
1. Be removed from production lines.
2. Not be loaded and shipped.
3. Not be installed or assembled on the Project Site until repairs or replacement parts are approved by authorized representative.

PART 3 EXECUTION

3.1 EXAMINATION

A. After lines and grades have been established by the General Contractor, but before beginning installation in any area, examine the supporting structure in the vicinity of storefront system work and report all conditions in writing to the General Contractor which would prevent the proper execution of the storefront system work or endanger its permanency.

B. Do not proceed with installation in the affected area until unacceptable conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written instructions for protecting, handling, and installing storefront system. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints. Seal joints watertight, unless otherwise indicated. Provide means to drain water to the exterior to produce a permanently weatherproof system.

B. Do not cut, trim weld, or braze component parts during erection, in any manner that would damage the finish, decrease the strength, or result in visual imperfection or failure in performance of the construction.

C. Metal Protection: 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. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

D. Install components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.

E. Install framing members plumb and true in alignment with established lines and grades.

F. Install factory-assembled frame units plumb and true in alignment with established lines and grades.

G. Anchorage: After system components are positioned, fix connections to building structure as indicated on Shop Drawings.
1. Provide separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

H. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

I. Install glazing according to Shop Drawings. Comply with requirements of Section 08 81 00 – Glass and Glazing, unless otherwise indicated.

J. Sealants and Related Materials: Use sealing materials in strict accordance with sealant manufacturer's printed instructions. Apply sealants only by mechanics specially trained or experienced in their use. Ensure that sealants, tapes, gaskets, separators, joint fillers, and back-up materials are physically and chemically compatible with each other and with adjacent materials. Before applying sealant, completely remove all mortar, dirt, dust, moisture, and other foreign matter from sealant bond surfaces. Clean metal surfaces with oil free solvent, such as Toluene or Xylene. Wash one small area at a time and then dry with a clean white cloth before solvent evaporates. Do not apply sealant to damp surfaces. Apply primers as required by manufacturer. Apply primer to stone bond surfaces to prevent staining. Mask adjoining surfaces when required to maintain a clean and neat appearance. Tool sealing compounds to fill the joint and provide a smooth finished surface.
   1. Thoroughly seal all metal-to-metal joints between elements of storefront system work by buttering joints with sealant immediately prior to the final assembly of abutting sections. Clean all excess sealant from exposed surfaces.
   2. Install sleeves, lugs, and related items in a full bed of sealant and seal perimeter when component is in final installed position as indicated or required by specified "Performance Requirements." Clean all excess sealant from exposed surfaces.

K. Install component parts level, plumb, true to line, and with uniform joints and reveals. Secure to structure with non-staining and non-corrosive shims, anchors, fasteners, spacers, and fillers. Use erection equipment that will not mar or stain finished surfaces in any way.

L. Clean debris, dust, and other substances from behind and adjacent to the storefront system work as it is erected, and provide temporary closures to prevent the accumulation of such substances in the void spaces behind the glazed window wall system.

M. Assembly and Anchorage:
   1. Anchor component parts securely in place, by bolting, welding, or other permanent mechanical attachment system, which will comply with performance requirements and expected movements of adjacent parts.
   2. Apply a bituminous coating of approximately 30-mil dry film thickness, or other suitable permanent separator, on concealed contact surfaces of dissimilar materials, before assembly or installation.
   3. Set sill members and other members with joint fillers and elastomeric sealant to provide weathertight construction.

N. Flashing: Provide flashings of the material and profiles indicated. Provide continuous flashings in longest lengths possible. Lap joints 12" minimum and seal concealed area of entire lap with curtain wall sealant. Provide mechanical fasteners to maintain contact of overlapping elements.

3.3 ERECTION TOLERANCES

A. Provide installed storefront system components conforming with to following erection tolerances:
   1. Maximum Deviation for Vertical Member: 1/8-inch maximum in story height of 13- feet and 1/4-inch maximum.
   2. Maximum Deviation for Horizontal Members: 1/8-inch maximum in a 30-foot run.
   3. Maximum offset from true alignment between two abutting members shall be 1/32-inch. No edge projection or misalignment will be permitted.
   4. Maximum joint gap or opening between removable glazing stop and adjacent member shall be 1/32-inch and/or a maximum 1/32-inch cumulative opening at both ends of removable member (1/64-inch each end).

3.4 CLEANING

A. Clean completed system, inside and out, promptly after erection and installation of glass and sealants (allow for nominal cure of liquid sealants). Contractor shall advise General Contractor of proper and adequate protection and cleaning procedures during remainder of construction period, so that the system will be without damage and deterioration at time of acceptance.
   1. Just prior to Date of Substantial Completion, clean windows, storefronts, and entrances thoroughly and polish glass. Demonstrate proper cleaning methods and materials to Owner's maintenance personnel.
   2. If work is done to correct punch list items on windows, storefronts, or entrances, re-clean affected windows, storefronts, and entrances thoroughly and polish glass prior to final completion.
   3. Submit a "Cleaning and Maintenance Manual" listing the types of cleaning compounds, cleaning methods, and the types of sealant and glazing materials to be used for cleaning, repair, and maintenance of the work, as specified.

3.5 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure windows, storefronts, and entrances are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 08 Section “Door Hardware Schedule”.
2. Division 08 Section “Hollow Metal Doors and Frames”.
3. Division 08 Section “Interior Aluminum Doors and Frames”.
4. Division 08 Section “Flush Wood Doors”.
5. Division 08 Section “Stile and Rail Wood Doors”.
6. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series

2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:

a. Type, style, function, size, label, hand, and finish of each door hardware item.
b. Manufacturer of each item.
c. Fastenings and other pertinent information.
d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
e. Explanation of abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for door hardware.
g. Door and frame sizes and materials.
h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

D. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s),

Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions

of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Five years for exit hardware.
3. Twenty five years for manual surface door closer bodies.
4. Twenty five years for manual surface door closer bodies.
5. Twenty five years for manual surface door closer bodies.

1.8 MAINTENANCE SERVICE

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

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in

writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

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

1. Quantity: Provide the following hinge quantity:

   a. Two Hinges: For doors with heights up to 60 inches.
   b. Three Hinges: For doors with heights 61 to 90 inches.
   c. Four Hinges: For doors with heights 91 to 120 inches.
   d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

   a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
   b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

   a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
   b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

   a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

   a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - TA Series.

B. Pivots: ANSI/BHMA A156.4, Grade 1, certified. Space intermediate pivots equally not less than 25 inches on center apart or not more than 35 inches on center for doors over 121 inches high. Pivot hinges to have oil impregnated bronze bearing in the top pivot and a radial roller and thrust bearing in the bottom pivot with the bottom pivot designed to carry the full weight of the door. Pivots to be UL listed for windstorm where applicable.

1. Manufacturers:

a. Rixson Door Controls (RF).

2.3 DOOR OPERATING TRIM

A. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
5. Manufacturers:
   a. Hiawatha, Inc. (HI).
   b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
   c. Trimco (TC).

2.4 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.

C. Cylinders: Original manufacturer cylinders complying with the following:

1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
5. Keyway: Match Facility Standard.

D. Keying System: Each type of lock and cylinders to be factory keyed.

1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Key locks to Owner's existing system.

E. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

F. Construction Keying: Provide construction master keyed cylinders.

G. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

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

1. Manufacturers:

a. Lund Equipment (LU).
b. MMF Industries (MM).
c. Telkee (TK).

I. Key Control Software: Provide one network version of "Key Wizard" branded key management software package that includes one year of technical support and upgrades to software at no charge. Provide factory key system formatted for importing into “Key Wizard” software.

2.5 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Manufacturers:

a. Sargent Manufacturing (SA) – 8200 Series.

2.6 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.7 CONVENTIONAL EXIT DEVICES

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

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

5. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.

6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

   a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
   b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.

9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

10. Rail Sizing: Provide exit device rails factory sized for proper door width application.

11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Manufacturers:

a. Sargent Manufacturing (SA) - 80 Series.

2.8 DOOR CLOSERS

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

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.

4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.

5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

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

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

1. Manufacturers:

a. Norton Door Controls (NO) – 9500 Series.
b. Sargent Manufacturing (SA) - 281 Series.

C. Door Closers, Overhead Concealed (Narrow Profile): ANSI/BHMA 156.4 certified Grade 1 door closers designed for narrow profile frames and doors. Closers to have fully concealed body in the frame head for offset hung applications, with separate and independent valves for closing speed and backcheck adjustments.

1. Manufacturers:

a. Rixson Door Controls (RF) - 91 Series.

2.9 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.

4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:

a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.

6. Manufacturers:

   a. Hiawatha, Inc. (HI).
   b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
   c. Trimco (TC).

2.10 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

   1. Manufacturers:

      a. Hiawatha, Inc. (HI).
      b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
      c. Trimco (TC).

2.11 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

   1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

   1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.12 FABRICATION

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

2.13 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection (Punch-Out Report): Reference Division 01 Section "Closeout Procedures". Final inspect installed door hardware and state in report whether work complies with or deviates from specification requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

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

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.

C. Manufacturer’s Abbreviations:

1. MK - McKinney
2. RF - Rixson
3. RO - Rockwood
4. SA - SARGENT
5. OT - OTHER
6. PE - Pemko

Hardware Sets

Set: 1.0

Doors: A100

Description: Exterior Pair, Vestibule Exit (AL)

2	Pivot Set	147	626	RF	087100
2	Intermediate Pivot	M19	626	RF	087100
1	CVR Exit, Nightlatch	LC AD8610 106	US32D	SA	087100
1	CVR Exit, Dummy	AD8610	US32D	SA	087100
1	Cylinder	Type and Size as required		OT	
2	Pull	RM201 Mtg-Type 12XHD	US32D	RO	087100
2	Concealed Closer	91N 90A	689	RF	087100
2	Door Stop	443	US26D	RO	087100
1	Threshold	271A		PE	087100
1	Rain Guard	346C		PE	087100
2	Sweep	3151CN		PE	087100
1	Hardware	Balance of Hardware by Door Provider		OT	

Notes: Perimeter seal by door/frame provider.

Set: 2.0

Doors: A100A
Description: Interior Pair, Vestibule (AL)

2	Pivot Set	147	626	RF	087100
2	Intermediate Pivot	M19	626	RF	087100
2	Push Bar	RM350 Mtg-Type 12XHD	US32D	RO	087100
2	Pull	RM201 Mtg-Type 12XHD	US32D	RO	087100
2	Concealed Closer	91N 90A	689	RF	087100
2	Door Stop	443	US26D	RO	087100
1	Hardware	Balance of Hardware by Door Provider		OT	

Notes: Perimeter seal by door/frame provider.

Set: 3.0

Doors: CXA, CXB
Description: Interior Single, Covered Corridor - Exit (AL)

4	Hinge (stainless heavy weight)	T4A3386 NRP (size as required)	US26D	MK	087100
1	Rim Exit Device, Classroom	LC 8813 ETL	US32D	SA	087100
1	Cylinder	Type and Size as required		OT	

1 Concealed Closer	91N 90A	689	RF	087100
1 Door Stop	443	US26D	RO	087100

Notes: Perimeter seal by door/frame provider.

Set: 4.0

Doors: N126, N127, N128
Description: Interior Pair, Corridor (AL)

2 Pivot Set	147	626	RF	087100
2 Intermediate Pivot	M19	626	RF	087100
2 CVR Exit, Passage	NB AD8615 ETL	US32D	SA	087100
2 Concealed Closer	91N 90A	689	RF	087100
2 Door Stop	443	US26D	RO	087100

Notes: Perimeter seal by door/frame provider.

Set: 5.0

Doors: A101, A102, A103, A104, H157, H159
Description: Interior Single, Study Room / Reading - Passage

4 Hinge	TA2714 (size as required)	US26D	MK	087100
1 Passage Latch	8215 LNL	US26D	SA	087100
1 Door Stop	443	US26D	RO	087100

Notes: Perimeter seal by door/frame provider.

Set: 6.0

Doors: M111A, M111B, M113A, M113B
Description: Interior Single, Lab - Classroom (AL)

4 Hinge	TA2714 (size as required)	US26D	MK	087100
1 Classroom Lock	LC 8237 LNL	US26D	SA	087100
1 Cylinder	Type and Size as required		OT	
1 Concealed Closer	91N 90A	689	RF	087100
1 Wall Stop	406	US26D	RO	087100

Notes: Perimeter seal by door/frame provider.

Set: 6.1

Doors: N119A, N119B, N119C
Description: Interior Single, OFC - Classroom (WD)

4 Hinge	TA2714 (size as required)	US26D	MK	087100
1 Classroom Lock	LC 8237 LNL	US26D	SA	087100
1 Cylinder	Type and Size as required		OT	
1 Surface Closer	281 O/P10 (as required)	EN	SA	087100
1 Wall Stop	406	US26D	RO	087100

Notes: Perimeter seal by door/frame provider.

Set: 7.0

Doors: A106, H158, M108, M111C, M111D, M113C
Description: Interior Single, Storage (WD)

4 Hinge	TA2714 NRP (size as required)	US26D	MK	087100
1 Storeroom Lock	LC 8204 LNL	US26D	SA	087100
1 Cylinder	Type and Size as required		OT	
1 Surface Closer	281 O/P10 (as required)	EN	SA	087100
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1 Wall Stop	406	US26D	RO	087100
1 Gasketing	S88BL		PE	087100

Set: 8.0

Doors: G107, H153, H154
Description: Interior Single, Passage (WD)

4 Hinge	TA2714 (size as required)	US26D	MK	087100
1 Passage Latch	8215 LNL	US26D	SA	087100
1 Surface Closer	281 O/P10 (as required)	EN	SA	087100
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1 Wall Stop	406	US26D	RO	087100
1 Gasketing	S88BL		PE	087100

Set: 9.0

Doors: C111
Description: Interior Single, Washer / Dryer (WD)

4 Hinge (heavy weight)	T4A3786 (size as required)	US26D	MK	087100
1 Passage Latch	8215 LNL	US26D	SA	087100

1 Surface Closer	281 CPS	EN	SA	087100
1 Armor Plate	K1050 34" high CSK BEV	US32D	RO	087100
1 Gasketing	S88BL		PE	087100

Set: 10.0

Doors: G106A
Description: Interior Single, Life Skills Restroom - Privacy (WD)

4 Hinge	TA2714 (size as required)	US26D	MK	087100
1 Privacy Lock	V21 8268 LNL	US26D	SA	087100
1 Surface Closer	281 O/P10 (as required)	EN	SA	087100
1 Mop Plate	K1050 6" high CSK BEV	US32D	RO	087100
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1 Wall Stop	406	US26D	RO	087100
1 Gasketing	S88BL		PE	087100

Set: 11.0

Doors: A107, A108
Description: Interior Single, R. R. (WD)

1 Pull Plate	BF 111x70C	US32D	RO	087100
1 Push Plate	70C-RKW	US32D	RO	087100
1 Mop Plate	K1050 6" high CSK BEV	US32D	RO	087100
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO	087100
1 Wall Stop	406	US26D	RO	087100
1 Gasketing	S88BL		PE	087100

Set: 12.0

Doors: M118A, M118B
Description: Overhead Door

1 Cylinder	Type and Size as required		OT
1 Hardware	Balance of Hardware by Door Provider		OT

Set: 13.0

Doors: LK
Description: Existing

1 Mortise Lock	LC 82-- LNL	US26D	SA	087100

1 Cylinder	Type and Size as required	OT

Notes: Field verify existing door/frame preps will fit specified hardware, coordinate with Architect. Provide new locking hardware, match function of new hardware to existing.

END OF SECTION 087100

08 81 00

GLASS AND GLAZING

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. Section includes furnishing and installing glass and glazing at the following locations indicated on the Drawings.
1. Door vision lites and sidelites.
2. Window vision and spandrel lites.
3. Interior vision lites.
4. Insulated Glazing Units for Curtain Walls and Storefronts.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Division 08 Section – Steel Doors and Frames.
2. Division 08 Section – Wood Doors.
3. Division 08 Section – Entrances and Storefronts.

1.4 DEFINITIONS

A. Manufacturer: A firm that produces primary glass or fabricated glass as defined in referenced glazing publications.

1.5 DESIGN/PERFORMANCE REQUIREMENTS

A. Design/Performance, General: Provide glazing systems that are capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following:
1. Defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thicknesses indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for various size openings in nominal thicknesses indicated, but not less than thicknesses and strengths (annealed or heat treated) required to meet or exceed the following criteria:
1. Glass Thicknesses: Select minimum glass thickness to comply with ASTM E1300, according to the following requirements:
a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet above grade, according to requirements of authorities having jurisdiction or ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade

indicated on Drawings, whichever are more stringent.
1) Basic Wind Speed (33 feet above finish grade): 147 mph 3 second gust.
2) Importance Factor: 1.15
3) Exposure Category: B.
4) Internal Pressure Coefficient: Indicate in the design calculations the internal pressure coefficient used in the design of exterior cladding and components

2. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15-degrees from vertical, and under wind action and with a load duration of 60 seconds or less.
3. Maximum Lateral Deflection: For the following types of glass specified in Part 2 - Products of this Section and supported on all four edges, provide the thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1-inch (25-mm), whichever is less.
   a. For monolithic glass heat-treated to resist wind loads.
   b. For insulating glass.
   c. For laminated glass lites.
4. Minimum Glass Thickness for Exterior Lites: Not less than 1/4 inch.
5. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120-degrees F, ambient; 180-degrees F, material surfaces.

1.6 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Samples: For the following products, in the form of 12-inch- square Samples for glass and of 12-inch- long Samples for sealants. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
1. Each color of tinted float glass.
2. Each type of laminated glass with colored interlayer.
3. Each sandblasted logo pattern on vision glass.
4. For each color (except black) of exposed glazing sealant indicated.

C. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

E. 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.

F. Warranties: Special warranties specified in this Section.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in

material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance.

B. Source Limitations for Glass: Obtain glass through one source from a single manufacturer for each glass type.

C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

D. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
   1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
   2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

E. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:
   1. 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.
   2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
   5. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

F. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.
   1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency or manufacturer acceptable to authorities having jurisdiction.
   2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in area, provide glazing products that comply with Category II materials, and for lites 9 sq. ft. or less in area, provide glazing products that comply with Category I or II materials.

G. Safety Glazing: Provide safety glazing as required by IBC 2006 for hazardous locations.
   1. Glazing in swinging doors and sidelights.
   2. Glazing in sliding doors and sidelights.
   3. Glazing in an individual fixed or operable panel adjacent to a door where the nearest exposed edge of the glazing is within a 24-inch arc of either vertical edge of the door in a closed position and where the bottom exposed edge of the glazing is less than 60 inches above the walking surface.

H. 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.

1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Sloped Glazing Guidelines."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

1.8 DELIVERY, STORAGE AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

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.

1.10 WARRANTY

A. Manufacturer's Special Warranty on Laminated Glass: Written warranty, made out to Owner and signed by laminated-glass manufacturer agreeing to furnish replacements for laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site. See Conditions of the Contact for additional warranty provisions. Provide 5-year special project warranty period for laminated glass products.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Provide clear float and tinted float glass required, produced by one of the following primary glass manufacturers.
   1. AFG Industries, Inc., Kingsport, TN (800) 251-0441
   2. Ford Glass Div., Allen Park, MI, (800) 521-6346.
   3. Guardian Industries, Carleton, MI (800) 521-9040.
   4. Pilkington Libbey-Owens-Ford, Toledo, OH (800) 526-6557.
   5. PPG Industries, Inc., Pittsburgh, PA (800) 377-5267

B. Provide each type of processed glass (coated, laminated, heat strengthened, fully tempered, or insulated glass) required, produced by one of the following:
   1. Viracon, Inc., Owatonna, MN (800) 533-2080 (Basis of Design)
   2. HGP & Affiliates, Inc., Dallas, TX (972) 663-3800.
   3. Glass Wholesalers, Inc., Houston, TX (713) 353-5800.
   4. PPG Industries, Inc., Pittsburgh, PA (800) 377-5267

C. Primary Float Glass Products: Provide lites of the following annealed primary glass types conforming to ASTM C 1036, including references to type, class, quality, and if applicable, form, finish, mesh and pattern. Provide heat strengthened or fully tempered glass complying with ASTM C 1048, including references to kind, condition, type, quality and class. Provide laminated glass complying with ASTM C 1172, including references to kind, condition, type, quality, and class.

D. Clear Low-E Coated Insulating Glass Type 1 (Clear Spectrally Selective Low-E Coated Fully Tempered Insulating Vision Glass Unless Otherwise Specified or Indicated): Provide units of the following construction and physical properties:
   1. Nominal Overall Thickness: 1 inch.
   2. Outer Lite: 6-mm (0.23-inch) thick clear float glass (Fully tempered where required by Code and Performance Requirements), with spectrally selective low-e coating on No. 2 surface.
   3. Insulating Unit Spacer: Manufacturer’s standard hermetically sealed dehydrated 13-mm (1/2-inch) black air space and complying with ASTM E 774, Class A requirements and with manufacturer's standard 13-mm (1/2-inch) spacer.
   4. Inboard Lite Assembly: One lite of 6-mm (0.23-inch) thick clear float glass (Fully tempered where required by Code and Performance Requirements).
   5. Visible Light Transmittance: 70 percent.
   6. Exterior Visible Light Reflectance: 11 percent.
   7. Interior Visible Light Reflectance: 12 percent.
   8. NFRC Winter Night Time U-Value: 0.29
   9. NFRC Winter Argon U-Value: 0.24
   10. Solar Heat Gain Coefficient: 0.22
   11. Light to Solar Heat Gain: 1.79
   12. Basis of Design: Vitro Architectural Glass clear Solarban 60 (2), or equivalent by Viracon or Pilkington as approved by Architect.

E. Clear Low-e Coated Insulating Spandrel Glass Type 1.1: Heat Strengthened (Or Fully Tempered) Exterior Insulating Spandrel Glass): Provide units with the following construction and physical properties:
   1. Nominal Overall Thickness: 1 inch.
   2. Outer Lite: 6-mm (0.23-inch) thick clear fully tempered float glass with spectrally selective low-e coating on No. 2 surface.
   3. Insulating Unit Spacer: Manufacturer’s standard hermetically sealed dehydrated 13-mm (1/2-inch) air space and complying with ASTM E 774, Class A requirements and with manufacturer's standard 13-mm (1/2-inch) spacer. Provide black painted aluminum spacer with black silicone sealant where exposed to view.
   4. Inboard Lite Assembly: One lite of 6-mm (0.23-inch) thick clear heatstrengthened (or fully tempered) float glass with ceramic coating in color as selected by Architect on No. 4 surface to match exterior appearance of Glass Type 1.

F. Fully Tempered Clear Float Glass: Condition A, Type I, Class 1, Quality q3, Kind FT, minimum 6-mm (0.23-inch) thick.

G. Clear 1-Hour Fire-Rated Ceramic Safety Impact Rated Glazing Material Type 7: SuperLite II-XL as manufactured by SaftiFirst, Brisbane, CA, 1-800-653-3333, or equivalent by Technical Glass Products, or Vetrotech Saint-Gobain.
   1. Makeup: 6 mm (1/4-inch) clear low iron PPG Starfire inboard and outboard lites and clear fire protecting intumescent interlayer.
   2. Thickness: 1/2 inch (13 mm).
   3. Weight: 6 lbs./sq. ft.
   4. Approximate Visible Transmission: 90 percent with Starfire low iron glass.
   5. Approximate Visible Reflection: 9 percent.]
   6. Fire-Rating: 45 minutes unless otherwise indicated. Fire rating listed and labeled by UL or Warnock Hersey for fire rating scheduled at opening locations on drawings, when tested in accordance with ASTM E 152 and ASTM E 163and UL 9 and UL 10B.
   7. Impact Safety Rating: ANSI Z97.1 and CPSC 16CFR1201 (Cat. I and II).
   8. STC Rating: Approximately 40 dB.
   9. Positive Pressure Test: UL 10C, UBC 7-2 and 7-4; passes.

H. Mirror Glass: ASTM C 1503, Mirror Glazing quality, clear annealed float glass, 6 mm (1/4-inch) thick, with 2 coats of chemically applied silver with electrolytic copper coating (0.0002" thick), followed by 2 protective coats of clear varnish or shellac applied to silvered and coppered surface and to all mirror edges, followed by final coat of mirror backing paint.

2.2 GLAZING GASKETS

A. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal.
1. Neoprene, ASTM C 864.
2. EPDM, ASTM C 864.
3. Silicone, ASTM C 1115.
4. Thermoplastic polyolefin rubber, ASTM C 1115.
5. Any material indicated above.

B. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal.
1. Neoprene, ASTM C 864.
2. EPDM, ASTM C 864.
3. Silicone, ASTM C 1115.
4. Thermoplastic polyolefin rubber, ASTM C 1115.
5. Any material indicated above.

2.3 MISCELLANEOUS GLAZING MATERIALS

A. Sealants, Tapes and Backup Materials: Provide sealants, tapes and backup materials of proven compatibility with other materials that they will contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience. Comply with sealant and glass manufacturer’s recommendations for selecting glazing sealants and tapes that are suitable for applications indicated and conditions existing at time of installation. Provide the following chemical curing, elastomeric sealants of the base polymer and movement capability indicated.
1. Non-Structural Silicone Glazing Sealant: One-part medium modulus silicone sealant with minimum ±50% joint movement capability and conforming to ASTM C 920, Type S, Grade NS, Class 25, Use NT, G, A, and as applicable to use indicated, O. Acceptable manufacturer and product includes General Electric Company "Silglaze II," or Dow Corning "Dow Corning 795."
2. Class 25 Neutral Curing Structural Glazing Sealant: Dow Corning Corporation; 799, General Electric "Ultraglaze SSG4000," or GE Silicones; UltraGlaze SSG4000AC.
3. Structural Silicone Glazing Spacers: Continuous preformed Type I Silicone Rubber Strips 50 ±5 Shore A durometer; designed to adhere to the structural glazing sealant.
4. Structural Silicone Setting and Edge Blocks: Preformed Type II Silicone Rubber Blocks, 85 ±5 Shore A durometer; designed to adhere to the structural glazing sealant.
5. Structural sealant manufacturer shall perform adhesion evaluation tests in accordance with ASTM C 794 using the sealant to be employed on production run samples furnished concurrently with the mock-up materials as well as with production runs of material to be used in the Work. Submit a quality assurance program, in addition to the specified tests, to monitor adhesion of sealant.
6. Glazing Tape: AAMA 806.3, 100% solids butyl tape with spacer rod; Tremco "Polyshim II" or PTI "PTI 303 Glazing Tape," except use glazing tape lite kits applicable to UL Listed (UBC 7-2 1997 and UL 10C) fire-rated glazing assembly time

ratings as produced by Zero International, or equivalent and specified as part of Section 08 71 00 - Door Hardware work.

7. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

B. Miscellaneous Glazing Materials: Provide products of material, size and shape complying with the referenced glazing standard, requirements of manufacturers of glass and other glazing materials involved for glazing application indicated, and with proven record of compatibility with surfaces contacted in installation.

1. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
2. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.
3. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
4. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
5. Mirror Mastic: Spot-application type, for 25% maximum coverage, 1/8" to 1/2" thickness; Palmer Mirro-Mastic, or equivalent approved by Architect.
6. Mirror Clips: AISI Type 302/304 stainless steel angle clips at mirror top and bottom edges, with No. 8 mirror polished finish.

2.4 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and 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 instructions of product manufacturer and referenced glazing standard, to comply with system performance requirements.

B. Exposed Glass Edges: Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with indoor and outdoor faces. Grind smooth and polish exposed glass edges.

C. Sizes, Clearances, Bite and Tolerances: Fabricate glass to the sizes required for glazed openings indicated, with edge and face clearances, bite and tolerances complying with recommendations of glass manufacturer and the referenced glazing standard, to comply with performance requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, 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 system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Inspect each piece of glass immediately before installation, and remove lites that have observable edge damage or face imperfections from the Project Site.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GLAZING PREPARATION

A. Clean framing members to receive glass, immediately before glazing. Remove coatings that are not firmly bonded to the substrate.

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. 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.

C. 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.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Center glass lites in each opening. Provide edge blocking to comply with requirements of referenced glazing standard, except where otherwise required by glass unit manufacturer.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where the length plus width is larger than 50 inches as follows:
   1. 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.
   2. 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.

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. Install tapes continuously, but not

necessarily in one continuous length. Do not stretch tapes to make them fit opening.

1. Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these joints by applying tapes to jambs and then to heads and sills.
2. 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.
3. Do not remove release paper from tape until just before each glazing unit is installed.

B. Apply heel bead of elastomeric sealant.

C. 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.

D. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance 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. 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. 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 PROTECTION AND CLEANING

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, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended 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 build-up of dirt, scum, alkaline deposits, or stains; remove as recommended by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including 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 by glass manufacturer.

END OF SECTION

09 20 00

GYPSUM BOARD AND LIGHT GAGE METAL FRAMING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes furnishing and installing:
1. Light Gage Metal Framing (Screw type steel board framing), framing for furring, and drywall ceiling suspension systems.
2. Gypsum drywall board, weather resistant gypsum sheathing board, abuse resistant gypsum board, and cementitious backing units.
3. Gypsum board accessories.
4. Gypsum board finishing.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Division 03 Section – Cast-In-Place Concrete.
2. Division 04 Section – Unit Masonry.
3. Division 05 Section – Cold-Formed Metal Framing.
4. Division 05 Section – Metal Fabrications.
5. Division 06 Section – Rough Carpentry for exterior plywood sheathing at mineral fiber cement siding.
6. Division 07 Section – Fluid-Applied Membrane Weather Barriers.
7. Division 07 Section – Joint Sealants.
8. Division 07 Section – Sound Batt Insulation
9. Division 08 Section – Hollow Metal Doors and Frames.
10. Division 08 Section – Entrances and Storefront.
11. Division 09 Section – Painting and Coating.

1.4 SUBMITTALS

A. Product Data: Submit product data for each board material and accessory required, including specifications showing compliance with requirements.

B. Samples: For the following products:
1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.5 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

B. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings,

provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.

C. References and Industry Standard Guidelines:
1. Association Publications
a. ASTM International. ASTM C 754: Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products. West Conshohocken, PA: ASTM, 2000.
2. National Gypsum Company. Gypsum Construction Guide. 7th ed. Charlotte, NC: National Gypsum Company, 2001.
3. USG Corporation. The Gypsum Construction Handbook. Centennial ed. Chicago, IL: USG Corporation, 2000.
4. Gypsum Association Fire Resistance Design Manual GA-600.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. 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. Stack gypsum panels flat to prevent sagging.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following:
1. Metal Support Materials;
a. Dale Industries, Inc., Dearborn, MI, (Tel) 313-846-9400.
b. Dietrich Industries, Inc., Hutchins, TX., (Tel) 214-225-1100.
c. Gold Bond Building Products Div., National Gypsum Co., Charlotte, NC, (Tel) 704-365-0950.
d. Amico/Maverick Steel Corp., Ennis, TX, (Tel) 800-528-5344.
e. Unimast, Inc., Mansfield, TX, (Tel) 817-473 9346.
2. Gypsum Board and Related Products:
a. G-P Gypsum Products, Decatur, GA, (Tel) 404-987-5190.
b. Gold Bond Building Products Div., National Gypsum Co., Charlotte, NC, (Tel) 704-365-0950.
c. United States Gypsum Co., Chicago, IL, (Tel) 312-321-4000.
3. Direct Suspension Systems:
a. Armstrong World Industries, Houston, TX, (Tel) 800-448-1405.
b. Chicago Metallic Corp., Chicago, IL, (Tel) 312-563-4600.
c. National Rolling Mills, Paoli, PA, (Tel) 215-644-6700.
d. United States Gypsum Co., Chicago, IL, (Tel) 312-321-4000.

2.2 FRAMING AND SUPPORT SYSTEMS

A. Light Gage Metal Framing: (Screw Type Steel Studs and Runners) ASTM C 645, fabricated from minimum 0.0179- inch thick zinc coated steel in sizes indicated, except provide minimum 0.0296-inch thick for studs used over limiting height or when required to support

wall hung heavy loads. Provide 1-1/2" x 1-1/2" angle runner at perimeter of ceiling suspension panels for support of board panel edge and extruded aluminum ceiling panel edge closure trim.

B. Non-Fire Rated Furring Bar Suspension System for Gypsum Board Ceilings: Armstrong 7900 Board Furring System with 7945 cross tees, HD 7801 wall angle, and 8887 board furring shoe, or equivalent by Chicago Metallic, or USG. Provide galvanized steel wire hangers, ASTM A 641, soft temper, sized so that stress at 3x hanger load (ASTM C 635, Table 1, Direct Hung) is less than wire yield stress. Size hanger anchorage devices for 3x calculated hanger load, except size direct pull-out concrete inserts for 5x calculated hanger load as determined by testing (ASTM E 488) conducted by a qualified independent testing agency. Coordinate with Division 09 Section - Acoustical Ceilings.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.3 BOARD MATERIALS

A. Gypsum Board: ASTM C 36, 5/8" thick, unless otherwise shown.
1. Fire rated (ASTM C 36, Type X requirements) where required for construction shown.
2. Base Layer: Gypsum board, ASTM C 442 or gypsum board, ASTM C 36.
3. Weather Resistant Gypsum Sheathing: Provide 1/2-inch thick, V-type T & G long edges and square butt ends, and with fiberglass reinforced faces for improved strength and weather resistance for up to 6 months of exposure; USG "Weatherock Exterior Sheathing" or Georgia-Pacific "Dens-Glass Gold."
   a. Sheathing Tape: Carlisle Hardcast “VaporGrip-22” joint seam, flashing and vapor barrier sealing tape with “CCW-702," “CCW-1402 Primer/Adhesion Enabler," or Hardcast “GlasGrip-658” adhesive.
4. Abuse Resistant Gypsum Board (Corridor Walls, Classrooms and Other Student Access Rooms, Except Toilet and Shower Rooms): ASTM C 1629, Level 1 surface indentation and soft body impact and level 3 surface abrasion, UL Classified for fire resistance (Type X), mold resistant (ASTM D 3273); Georgia- Pacific Gypsum LLC “DensArmour Plus Abuse-Resistant Interior Panels," 5/8- inch thick.
5. Cementitious Backer Units (Toilet and Shower Rooms): ANSI A118.9 and ASTM C 1288 or C 1325; U.S. Gypsum “Durock Cement Board,” James Hardie Building Products “Hardiebacker,” or National Gypsum Company “Permabase Cement Board."

2.4 MISCELLANEOUS MATERIALS, ACCESSORIES, AND TRIM

A. 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.

B. Galvanized steel casing beads, corner beads, and other metal trim accessories as required.

C. Joint Tape: ASTM C 475, plain or perforated.

D. Interior Joint Compound: ASTM C 475 in two grades; one for bedding tape and filling depressions and one for topping and sanding.

E. Joint Compound for Water Resistant Backing Board: Setting type for filling joints and treating fastener heads.

F. Acoustical Sealant: See Section 07 92 00 – Joint Sealants.

G. Acoustical Foam Double Stick Tape: Norton Plastics Corp., V740 Multipurpose medium density foam tape, 1/4” x 2” wide.

H. Electrical box sound pads by Harry Lowery & Associates, Sun Valley, CA, (Tel) 818-768-4661.

I. Acoustical Foam Gasket: Norton foam sealant tape, 1-1/2” x 1/8”.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollowmetal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordination with Sprayed Fire-Resistive Materials:
1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed-on fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of gypsum board assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLING STEEL FRAMING, GENERAL

A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation, except as follows:
1. Partitions With Brittle Finishes: Use stud manufacturer's published limiting heights for construction and single span conditions with a limiting deflection of L/360 and uniform transverse load values as indicated on the Drawings.
2. Partitions Without Brittle Finishes, More Than 10'-0" High: Use stud manufacturer's published limiting heights for construction and single span conditions with a limiting deflection of L/240 and uniform transverse load values as indicated on the Drawings.
3. Do not bridge building expansion joints with support system. Frame both sides of joints with supports as indicated.
4. Install supplementary framing, blocking and bracing at terminations in the work and for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, and similar work to comply with details indicated or if not otherwise indicated, to comply with applicable published recommendations of gypsum board manufacturer, or if not available, of "Gypsum Construction Handbook" published by US Gypsum Co.
5. Isolate stud system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading.
6. Install runner tracks at floors, ceilings, and structural walls and columns where gypsum board stud system abuts other work, except as otherwise indicated.
7. Terminate partition stud system at ceilings, except where indicated to be extended to structural support or substrate above.
8. Space studs 16" o.c., unless otherwise indicated.
9. Frame door openings to comply with details indicated. If not shown, comply with applicable published recommendations of gypsum board manufacturer or of "Gypsum

Construction Handbook" published by U. S. Gypsum Co. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for jack studs) at head and secure to jamb studs.

10. Frame openings other than door openings to comply with details indicated or if not indicated, in same manner as required for door openings; and install framing below sills of openings to match framing required above door heads.
11. Space wall furring members 24" o.c., unless otherwise indicated.

3.4 INSTALLING CEILING SUPPORT SUSPENSION SYSTEMS

A. Secure hangers to structural support by connecting directly to structure where possible; otherwise connect to inserts or other direct pullout type anchorage devices as specified.

B. Suspend ceiling 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 ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter splaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
4. Do not support ceilings directly from permanent metal forms. Furnish cast-inplace hanger inserts that extend through forms.
5. Do not attach hangers to steel deck tabs.
6. Do not attach hangers to steel roof deck. Attach hangers to structural members.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

C. Space main runners 4'-0" o.c. and space hangers 4'-0" o.c. along runners, except as otherwise shown.

D. Level main runners to a tolerance of 1/8" in 12'-0", measured both lengthwise on each runner and transversely between parallel runners.

E. Furring Bar Suspension Support System: Attach perimeter wall track or angle wherever support system meets vertical surfaces. Mechanically joint support members to each other and butt-cut to fit into wall track.
1. Main Runners: Support directly from wire hangers spaced at 4' o.c.; locate not more than 6" from parallel walls and space not more than 4' o.c., between parallel walls. Install manufacturer's standard splicing device at joints.
2. Cross Runners: Support by interlocking ends of cross runners with main runners to form 90 degree angle between intersecting runners. Locate not more than 6" from parallel walls and space not more than 24" o.c.
3. Other Components: Provide as recommended by manufacturer for support of other work resting in, or on, ceiling.
4. Install auxiliary framing at termination of board work, and at openings for light fixtures and similar work, as required for support of both the board construction and other work indicated for support thereon.

F. Carrying Channel and Rigid Furring Channel Suspension System: Attach 1-1/2" carrying channels (main runners) to hangers at maximum 48" on center. Install rigid furring channels

at maximum 16" on center. Level support system to a tolerance of 1/8" in 12'-0", measured both lengthwise on each channel and transversely across adjacent parallel channels. Install auxiliary framing at termination of board work, and at openings for light fixtures and similar work, as required for support of both the board construction and other work indicated for support thereon. Cold rolled steel channels shall weigh not less than 300-lb./1000 lf. for 3/4-inch size, and 475-lb./1000 lf for 1-1/2- inch size; rust-inhibitive paint for interior locations except hot-dipped galvanized at "high humidity" areas.

3.5 APPLYING AND FINISHING PANELS, GENERAL

A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.

B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

D. Install gypsum 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.

E. 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.

F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

G. Attach gypsum panels to framing provided at openings and cutouts.

H. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members using resilient channels, or provide control joints to counteract wood shrinkage.

I. Form control and expansion joints with space between edges of adjoining gypsum panels.

J. Cover both faces of steel stud partition 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 open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
   4. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
   5. STC-Rated Assemblies: Seal construction at perimeters, behind control and expansion 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 manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around

or through gypsum board assemblies, including sealing partitions above acoustical ceilings.

6. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

3.6 SINGLE LAYER APPLICATION

A. Partition/Walls: Apply gypsum board vertically with vertical joints located over supports, but offset at least one stud space on opposite faces of partition/walls. Use maximum practical length boards to minimize end joints.

B. Ceilings: Apply gypsum board with long dimension at right angles to supports with end joints located over supports. Use maximum practical length boards to minimize end joints. Stagger end joints in alternate courses of boards and locate as far away from center of ceiling as possible.

3.7 DOUBLE LAYER APPLICATION

A. Mechanically Fastened Layers: Fasten both layers to supports with screws. For base layer, do not exceed 24" o.c. spacing at edges and intermediate supports, and for face layer do not exceed 16" o.c. spacing along supports of non-fire rated construction. At fire rated construction, comply with requirements of fire rated design indicated.

B. On walls, apply both layers vertically with vertical joints staggered on opposite side of partitions and offset not less than 12" between layers.

C. On ceilings, apply first layer as specified for single layer application prior to wall face layer application; apply face layer on ceiling, offsetting joint between layer at least one back-up member spacing in both directions.

3.8 INSTALLATION OF BOARD TRIM AND ACCESSORIES, GENERAL

A. Where feasible, use the same fasteners, to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges by nailing or stapling in accordance with manufacturer's instructions and recommendations.

1. Install metal corner beads at external corners of board work.
2. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed. Provide type with face flange to receive joint compound. Install L-type trim where work is tightly abutted to other work, and install special kerf-type where other work is kerfed to receive long leg of L-type trim. Install U-type trim where edge is exposed, revealed, gasketed, or sealant filled (including expansion joints).

3.9 INSTALLATION OF GYPSUM SHEATHING

A. Except as otherwise indicated, comply with manufacturer's instructions and industry standards for the installation of gypsum sheathing.

1. Install 2-foot wide panels horizontally with V-grooved edge down, and with end joints on supports and staggered two support spacings where possible, but not less than one support spacing or 12-inches.
2. Fasten at each support with four screws (spaced approximately 8-inches on center) set back 3/8-inch minimum from edge.
3. Cut boards at penetrations, edges, and other obstructions of the work; fit tight against abutting work, except provide 3/8-inch setback where non- load bearing work abuts structural elements at head and jambs.
4. Do not bridge building expansion joints with gypsum sheathing; cut and space edges to match spacing of structural support elements.

3.10 FINISHING GYPSUM BOARD ASSEMBLIES

A. Apply treatment at gypsum board joints (both directions), flanges of trim accessories, penetrations, fastener heads, surface defects and elsewhere as required to prepare work for decoration. Prefill open joints and rounded or beveled edges, if any, using type of compound recommended by manufacturer.

B. Exposed Board to Receive Paint and Other Finishes (Except Tile): Apply joint compound in 3 coats (not including prefill of openings in base), and sand between last two coats and after last coat.

C. Concealed Board: Omit third coat and sanding on concealed board work which is not indicated for board finishing or for which finishing is not required to achieve fire resistance rating, sound rating or to act as air or smoke barrier.

D. Water-Resistant Backing Board Tiled Areas: Comply with recommendations of gypsum backing board manufacturer for treatment of joints behind ceramic tile.
   1. Treat fastener heads with water-resistant joint compound.
   2. Fill tapered edges in gypsum panels with water-resistant joint compound, embed joint tape firmly and wipe off excess compound; follow immediately with a second coat of water-resistant joint compound over taping coat, being careful not to crown the joint.
   3. Fold and embed tape in all interior angles to form true angles.
   4. In water-resistant backing board areas not to be tiled, treat fastener heads and embed tape as indicated above using water-resistant joint compound but finish with two coats of joint compound used for regular gypsum board work.

E. Provide the following levels of gypsum board finish per ASTM C 840 and GA-214:
   1. Level 0: Gypsum board within unfinished areas; taping, floating and trim is not required.
   2. Level 1: Gypsum board within ceiling plenum areas, concealed areas, unless a higher finish is required for fire resistance rated assemblies and sound rated assemblies.
   3. Level 2: Gypsum board substrates to receive ceramic tile and similar solid finish materials.
   4. Level 3: Gypsum board ceiling and wall surfaces to receive flat and satin paint over non-textured surfaces.
   5. Level 4: Gypsum board wall surfaces to receive flat or semi-gloss paint and.
   6. Level 5: Gypsum board ceiling and wall surfaces specified to receive gloss paint and other reflective applied finishes over non-textured surfaces.

END OF SECTION

09 30 00

TILING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes furnishing and installing:
1. Thin set unglazed porcelain mosaic tile at floor and base areas indicated.
2. Thin set mortar for thin set floor tile.
3. Organic adhesive for wall tile installation.
4. Unsanded grout at wall, base, and floor tile.

B. Related Work of Other Sections:
1. Section 03 30 00 – Cast-In-Place Concrete.
2. Section 06 10 00 – Rough Carpentry.
3. Section 07 92 00 – Joint Sealants.
4. Section 09 21 16 – Gypsum Board Assemblies for cementitious tile backing boards.
5. Section 10 28 13 – Toilet Accessories.
6. Section 10 21 13 19 – Solid Plastic Toilet Compartments.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for manufactured products and accessories.

B. Samples: Submit grout color samples. If requested by Architect provide grouted actual tile samples, approximately 1-ft sq., of each type and color of tile and grout required.

1.4 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. 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.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Tile Selections:
1. Refer to Finish Legend on the Drawings for tile selections, sizes, color and texture required and to Finish Schedule for locations required.

2.2 SETTING MATERIALS, GROUT AND ACCESSORIES

A. Use the following setting materials and grout in accordance with ANSI A 108 series installation specifications indicated and Tile Council of American "Ceramic Tile: The Installation Handbook".

B. Dry-Set Mortar (Thin Set Floors): Bostik "Tile-Mate 710/713" with "Hydroment Multi-Purpose Acrylic Additive", complying with ANSI A 118.1 and ANSI A 108.5 installation specifications. Subject to compliance with requirements, provide equivalent products by C-Cure, Mapei or Texas Cement Products will be acceptable as approved.

C. Organic Tile Adhesive (Thin Set Walls): Bostik "7001 Mastic", complying with ANSI A 136.1, Type I, and ANSI A 108.4 installation specifications. Subject to compliance with requirements, provide equivalent products by C-Cure, Mapei or Texas Cement Products will be acceptable as approved.

D. Grout: ANSI A118.6; Laticrete 1600 Series (Unsanded), in colors as selected by Architect. Subject to compliance with requirements, provide equivalent products by C-Cure, Bostik, Mapei, or Texas Cement Products will be acceptable as approved. Install grout in accordance with ANSI A108.10 installation specifications.
   1. Grout Colors: Refer to Finish Legend and Finish Schedule on the Drawings for product selections, colors, sizes and locations.

E. Metal Edge Trim: Schuter-Systems A 80 5/16" high extruded aluminum edge trim.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the areas and conditions under which ceramic tile work is to be applied and do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 PREPARATION

A. Preparation of Subfloors: Prior to start of applying ceramic tile work, broom clean, or vacuum surfaces to be covered and inspect the subfloor. Start of application operations will indicate acceptance of surface conditions and full responsibility for the completed work.

3.3 TILE BACKING PANEL INSTALLATION

A. Install cementitious backer units and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.4 INSTALLATION

A. Comply with the applicable parts of ANSI A 108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile" and the Tile Council of America "Ceramic Tile: The Installation Handbook".
   1. Dry-Set (Thin-Set) Floor Tile and Glass Wall Tile: ANSI A108.5.
   2. Organic Adhesive Set Wall Tile: ANSI A 108.4.
   3. Tile Set in Portland Cement Mortar Bed: ANSI A 108.1.
   4. Sanded and Dry-Set Tile Grout: ANSI A108.10

B. Handle, store, mix, and apply proprietary setting and grouting materials in compliance with the manufacturer's instructions.

C. Extend tile work into recesses and under fixtures to form a complete covering without

interruptions. Terminate work neatly at obstructions, edges, and corners without disruption of pattern or joint alignment.

D. Jointing Pattern: Lay tile with joint pattern to produce design indicated. Align joints on floor, base, walls, and trim. Lay out tile work and center tile field in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform grouted joint widths.

E. Expansion and Control Joints: Provide where shown, and as recommended in the TCNA "Handbook for Ceramic Tile Installation". Install removable strips of the same depth as the finished tile system. Remove strips after grouting and curing operations. Refer to Section 07 92 00 for sealants.

3.5 GROUT INSTALLATION

A. Use unsanded cement grout for grouting wall and floor tile joints.

B. Use sanded cement grout for grouting large format tile.

3.6 CLEANING

A. Unglazed tile may be cleaned with acid solutions only when permitted by the tile and grout manufacturer's printed instructions, but not sooner than ten days after installation.

B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and other defective tile work.

C. Protection: Protect installed ceramic tile work with Kraft paper or other heavy covering during the construction period to prevent damage and wear.

END OF SECTION

09 51 00

ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes furnishing and installing:
1. Exposed tee suspension system and lay-in acoustical panels.
2. Acoustical ceiling trim and accessories, including edge trim for ceiling clouds.
3. Additional hanger wires to support mechanical and electrical fixture that bear on suspension grid.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 09 21 16 – Gypsum Board Systems: Drywall suspension systems.
2. Section 09 90 00 – Painting and Coating.
3. Division 23 and 26 Sections - Mechanical and Electrical Fixtures Installed in ceilings.

1.4 DESIGN/PERFORMANCE REQUIREMENTS

A. Comply with ASTM C 635 for materials and ASTM C 636 for installation. Where fire rated assemblies are indicated, comply with the requirements of the UL designs shown.
1. Provide lighting fixture protection in accordance with UL requirements for the design indicated.
2. Provide hanger wires as recommended by the suspension system manufacturer to comply with the structural classification specified (ASTM C 635), but not less than 12-gage galvanized wire (ASTM A 641).
3. Direct wire tie to structure or provide attachment devices sized for not less than 5x design loads involved as determined by testing (ASTM E 488) conducted by a qualified independent testing agency.

1.5 SUBMITTALS

A. Submit manufacturer's product data and samples showing compliance with specified requirements.

1.6 QUALITY ASSURANCE

A. Acoustical Panel Standard: Comply with ASTM E 1264.

B. Metal Suspension System Standard: Comply with ASTM C 635.

C. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory.

D. Fire-Test-Response Characteristics:
   1. Surface-Burning Characteristics: Acoustical panels complying with ASTM E 1264 for Class A materials, when tested per ASTM E 84 and a smoke-developed index of 450 or less.

1.7 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. Acoustical Ceiling Units: Full-size units equal to 2.0 percent of quantity installed, but not fewer than two full cartons.
   2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed, but not fewer than two full cartons each.

PART 2 PRODUCTS

2.1 CEILING SUSPENSION GRIDS

A. Non-Fire Rated Exposed Grid Suspension System (Grid for Ceiling Type 1): Provide Armstrong "Prelude XL" suspension system for 4' x 4' module, or equivalent by Chicago Metallic, Donn or USG Interiors as approved. Provide system complying with ASTM C 635 intermediate-duty requirements, with 1-1/2" deep main and cross runners, and 15/16” wide smooth matte white painted aluminum cap and 15/16” wide angle moldings.

2.2 ACOUSTICAL PANELS

A. Standard Acoustical Lay-In Panels (Lay-In Panel Type 1): Armstrong "Cortega Square Lay-in" design, Item No. 770, 24" x 24" x 5/8" thick, 0.50 NRC, 33 CAC, 0.82 Light Reflectance, Class A Flame Spread, 1 year sag resistance warranty, white standard finish, with square edges on 4 sides for Type 1 suspension grid specified in this Section or equivalent by USG Interiors, Radar, ClimaPlus.

B. Scrubbable Acoustical Lay-In Panels (Lay-In Panel Type 2): Armstrong “Kitchen Zone” 673 Square Lay In, design Item No. 673, 24” x 24” x 5/8” thick, 33 CAC, 0.89 Light Reflectance, Class A Flame Spread, 1 year sag resistance warranty, white standard finish, with square edges on 4 sides for Type 1 suspension grid specified in this Section or equivalent by USG Interiors, Radar, ClimaPlus.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
   1. Install non-fire rated assemblies in accordance with manufacturer's instructions; requirements of Article 2 "Installation of Components" of "Standard Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels" ASTM C 636; and as specified.
   2. Hangers: Space not more than 6-inch from each end and not more than 4-feet on center between ends of members to be supported. Provide additional hangers as required to prevent eccentric deflection or rotation of supporting runners.
   3. Moldings: Install where ceilings meet vertical surfaces. Cut and bend to conform to outside corners; cut and butt at inside corners.
   4. Do not bear supporting members on walls or partitions.

B. 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 tiles at borders.

C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices.
   1. Do not support ceilings directly from permanent metal forms or floor deck; anchor into concrete slabs.
   2. Do not attach hangers to steel deck tabs or to steel roof deck.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels. Screw attach moldings to substrate with concealed fasteners at intervals not more than 16-inches (400-mm) on center 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.

E. Exposed Grid Systems:
   1. Support main runners directly from hangers. Space main runners to support acoustic panels and other work resting in, or on, the ceiling, comply with performance requirements. Provide additional hanger wares at all four corners of grid surrounding lay-in light fixtures and other heavy loads supported directly by ceiling grid. Interlock cross- runners with either main runners or with crossrunners structurally classified as main runners.
   2. Install angle type moldings with exposed leg in same plane as bottom flange of runners.
   3. 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. Install square edge panels to rest on flanges of grid tees with border units supported by moldings. Install acoustic units in accordance with manufacturer's printed applicable instructions and recommendations only when:
   1. Exterior openings have been closed and roofs are weathertight.
   2. Mechanical, electrical, and other work above ceilings has been completed.
   3. Wet work has been installed.
   4. Temperature and relative humidity levels comply with acoustic material manufacturer's recommendations.

G. Cleaning and Repairs: Clean exposed surfaces; comply with manufacturer's instructions. Remove and replace damaged units and members.

END OF SECTION

09 65 00

RESILIENT FLOORING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes furnishing and installing:
1. Vinyl composition tile flooring (VCT).
2. Luxury vinyl tile flooring (LVT).
3. Rubber (resilient) base.
4. Cleaning, waxing and buffing of resilient flooring.

B. Related Work of Other Sections:
1. Section 03 30 00 “Cast-In-Place Concrete.”
2. Section 09 90 00 “Painting and Coating.”

1.3 ACTION SUBMITTALS

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

B. Samples for Initial Selection: For each type of product indicated.

C. Samples for Verification: Full-size units of each color and pattern of resilient flooring required.
1. Resilient Wall Base and Accessories: Manufacturer's standard-size Samples, but not less than 12-inches long, of each resilient product color and pattern required.
2. Architect's approval will be for color and texture only; compliance with other requirements is Contractor's exclusive responsibility.

D. Maintenance Data: For resilient products to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide products identical to those tested for fire exposure behavior per test method indicated by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 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-degrees F or more than 90-degrees F. Store tiles on flat surfaces.

1.6 PROJECT CONDITIONS

A. Maintain temperatures as range recommended by manufacturer, but not less than 70-

degrees F or more than 95-degrees F, in spaces to receive floor tile during the following time periods:
1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After post-installation period, maintain temperatures within range recommended by manufacturer, but not less than 55-degrees F or more than 95-degrees F.

C. Close spaces to traffic during floor covering installation.

D. Close spaces to traffic for 48-hours after floor covering installation.

E. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Vinyl Composition Tile: 12" x 12", 1/8" thick, ASTM F 1066, Class 2 (Through Pattern); Armstrong Commercial Flooring: Standard Excelon with Premium Excelon accents accounting for up to 25% of finish area, as selected by Architect from available colors, or equivalent produced by Tarkett or Mannington, as approved.
1. Refer to drawings for types selected by architect.

B. Luxury Vinyl Tile: Armstrong Commercial Flooring: Natural Creations with Diamond 10 Technology, as selected by Architect from available colors, or equivalent produced by Tarkett or Mannington, as approved.
1. Refer to drawings for types selected by architect.

C. Rubber Base: ASTM F 1861, Type TS; 2-1/2-inch high, 1/8-inch thickness, standard topset cove thermoset vulcanized rubber base at resilient flooring and straight base at carpeted areas as indicated; Roppe No. 193 "Black Brown" or equivalent by Allstate.

2.2 ACCESSORY MATERIALS

A. Adhesives (Cements): Full-spread adhesive for direct application to concrete floors, as recommended by flooring manufacturer. Do not use asphalt emulsions and other non-waterproof adhesives.

B. Adhesive Primer: Non-staining type as recommended by flooring manufacturer.

C. Latex Modified Portland-Cement Based Self-Leveling Underlayment: Ardex "K-15", Cormix "Corlevel", or Sonneborn "Sonoflow", or equivalent including bonding agent (if any) recommended by underlayment manufacturer.

D. Metal Edge Trim: Schuter-Systems A 30, 1/8" high extruded aluminum edge trim, or equivalent.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which resilient flooring and accessories are to be installed and do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

B. Confirm that concrete has cured a minimum of 60-days prior to scheduling installation of flooring and that no rain or water from all sources has been allowed to stand on concrete. floor areas scheduled to receive flooring materials for a minimum of 30-day prior to flooring installation.

C. Moisture Vapor Emission Tests: Test each 1,000-sq. ft. of flooring substrate, or portion thereof, with an anhydrous calcium chloride test kit equivalent to the Vaprecision Test Kit produced by Vaprecision Professional Vapor Emission Testing Systems, Newport Beach, CA (Tel) 800-449-6194, or equivalent.
   1. Conduct tests for a minimum of 72 hours in accordance with the test kit manufacturers printed instructions.
   2. An emission rate of less than 3.0-lb./1,000 sq. ft. in 24 hours indicates that substrate is acceptable for flooring installation.
   3. If emission rates are 3.0-lb./1,000 sq. ft. in 24 hours or greater anywhere in the area tested, submit a written test report to Architect and Owner within 24 hours, indicating the type of test kit used and the test results at each location tested.
   4. In addition, submit a proposal to furnish and install a vapor emission control penetrant system, or a vapor emission control coating system, or a vapor emission control dispersal membrane system as dictated by test results and produced by Floor Seal Technology, Inc., San Jose, CA (Tel) 800-572-2344, or one of the appropriate “VaprStop” fast-cure epoxy concrete water vapor sealer system produced by DuPont Flooring Systems, Kennesaw, GA (Tel) 800-438-7668, or www.dupontcommercial.com, or equivalent.

D. pH Tests: Two days prior to scheduled flooring installation date, test each 1,000-sq. ft. of flooring substrate, or portion thereof to determine the pH of concrete substrates to receive flooring has a pH of about 9.0 in accordance with ASTM F 710.
   1. Confirm that tests of pH levels are within limits permitted by flooring adhesive manufacturer prior to installation of flooring.
   2. Do not grind, shot blast, or perform similar operations that will remove the top surface of cured concrete substrates scheduled to receive flooring unless specifically concrete substrate deficiency.

3.2 PREPARATION

A. Prior to laying flooring, vacuum-sand concrete and wood floor surfaces to be covered and inspect subfloor. Start of flooring installation will indicate acceptance of subfloor conditions and full responsibility for completed resilient flooring work. Patch holes and defects in existing substrates indicated to receive resilient flooring materials.

B. Apply adhesive primer, as recommended by flooring manufacturer, prior to application of adhesive.

3.3 TILE INSTALLATION

A. Install flooring after finishing operations, including painting, have been completed and permanent heating system is operating. Moisture content of subflooring, building airtemperature, and relative humidity shall be within limits recommended by flooring manufacturer.

B. Place flooring with adhesive cement in strict compliance with flooring and adhesive manufacturer's printed instructions. Butt tightly to vertical surfaces, thresholds, nosings, and edgings. Scribe around obstructions to produce neat, tight, even, and straight joints. Extend flooring into toe spaces, door reveals, and into closets and similar openings.

C. Tightly cement flooring to subbase without open cracks, voids, raising, and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections.

D. Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of the room are equal width. Adjust to avoid use of cut widths less than 3" wide at room perimeters. Lay tile square to room axis.

E. Match tiles for color and pattern by using tile from cartons in same sequence as manufactured and packaged. Cut tile neatly to and around all fixtures. Broken, cracked, chipped, or deformed tile will not be acceptable.

F. Lay tile with grain in the same direction as directed by Architect; basket weave installation is not acceptable.

3.4 INSTALLATION, ACCESSORIES

A. Place resilient edge strips tightly butted to flooring and secure with adhesive. Install edging strips to all unprotected edges of flooring.

3.5 CLEANING AND PROTECTION

A. Remove excess adhesive and other surface blemishes from flooring and base, using types of cleaners as recommended by flooring manufacturer.

B. Protect installed flooring from damage by covering with approved coverings.

C. Finishing: Just prior to final inspection of the Work, thoroughly clean new and existing floors and accessories and apply type of wax and buff as recommended in resilient flooring manufacturer's printed instructions for proper care and finishing of resilient flooring furnished.

END OF SECTION

09 68 00

CARPETING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes furnishing and installing:
1. Adhesive (direct glue-down) sheet carpeting (broadloom).
2. Modular carpet tile.

B. Related Work of Other Sections:
1. Division 03 Section “Cast-In-Place Concrete.”
2. Division 09 Section "Resilient Flooring" for resilient wall base and accessories installed with carpet.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's product literature for each type of carpet and accessory required.

B. Shop Drawings: Submit seaming diagrams for the entire work

C. Samples: Submit samples not less than 12" square of each different type of carpet and not less than 12" long of each different type of accessory as requested by Architect.

D. Product Schedule: Use same designations indicated on Drawings.

E. Maintenance Data: For carpet s to include in maintenance manuals. Include the following:
1. Methods for maintaining carpet, 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.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm with not less than 5 years successful experience in carpet installations similar in size and type to carpeting work required for this project.

B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

C. Field Measurements: Measure each space to receive carpeting, as a basis for supplying, cutting, and seaming the carpet. Do not scale the Architect's drawings or calculate sizes from indicated dimensions.

1.5 SEQUENCING AND SCHEDULING

A. Sequence and schedule carpeting with other work to minimize the possibility of damage and soiling of carpet during the remainder of the construction period.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104, Section 5, "Storage and Handling."

1.7 PROJECT CONDITIONS

A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."

B. Environmental Limitations: Do not install carpet s until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

C. Do not install carpet s over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Interface, LLC.
2. Milliken & Company.
3. Mohawk Group (The); Mohawk Carpet, LLC.
4. Tandus; a Tarkett company.

2.2 CARPET TILE

A. Color and Pattern: As selected by Architect from manufacturer's full range.

B. Fiber Content: 100 percent nylon 6.

C. Fiber Type: Antron.

D. Pile Characteristic: Tufted-loop pile.

E. Pile Thickness: 1/2 for finished carpet tile according to ASTM D6859.

F. Backing: Performance backing. Seam sealers and chair pads shall NOT be required to maintain the warranty.

G. No latex backing shall be used.

H. Total Weight: 26 oz./cu. yd for finished carpet tile.

I. Size: 24 by 24 inches.

J. Applied Treatments:
1. Soil-Resistance Treatment: Manufacturer's standard treatment.

2.3 BROADLOOM CARPET

A. Color and Pattern: As selected by Architect from manufacturer's full range.

B. Fiber Content: 100 percent nylon 6.

C. Fiber Type: Antron.

D. Pile Characteristic: Tufted-loop pile.

E. Pile Thickness: 1/2 for finished carpet tile according to ASTM D6859.

F. Backing: Performance backing. Seam sealers and chair pads shall NOT be required to maintain the warranty.

G. No latex backing shall be used.

H. Total Weight: 26 oz./cu. yd for finished carpet tile.

I. Size: Per manufacturer’s standard, but no less than 12 feet wide.

J. Applied Treatments:
1. Soil-Resistance Treatment: Manufacturer's standard treatment.

2.4 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cementbased formulation provided or recommended by carpet manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended by carpet manufacturer for releasable installation.
1. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).

C. Accessories: Provide Mercer "Royal Commercial C/E" No. 101 carpet bar and "Imperial Reducer" No. 101 vinyl reducing strip, or approved equivalent.

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 performance. Examine carpet 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 manufacturer.
2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast- In-Place Concrete" for slabs receiving carpet.
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 manufacturer's written installation instructions for preparing substrates indicated to receive carpet 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 (3 mm) 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 manufacturer.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

A. Installation Method: As recommended in writing by carpet manufacturer.

B. Maintain dye lot integrity. Do not mix dye lots in same area.

C. Cut and fit carpet 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 manufacturer.

D. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

E. 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, nonstaining marking device.

F. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet :
   1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
   2. Remove yarns that protrude from carpet surface.
   3. Vacuum carpet using commercial machine with face-beater element.

B. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."

C. Protect carpet 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 manufacturer.

END OF SECTION

09 90 00

PAINTING AND COATING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and the application of painting and coating systems on the following substrates:
1. All exterior ferrous metals, except as specified.
2. All exterior non-ferrous metals, except as specified.
3. Exterior concrete and plaster with painted finish.
4. Interior wood with painted finish.
5. All interior ferrous metals, except as specified.
6. All interior non-ferrous metals, except as specified.
7. Interior concrete masonry with painted finish.
8. Interior concrete and plaster with painted finish.
9. Interior gypsum drywall with painted finish.
10. All prime coated hardware and other factory primed metal items.
11. All prime coated hardware and other factory primed metal items.
12. Exposed fire protection piping, valves and standpipes, excluding sprinkler heads, valve tags, name plates, and exposed operating components of motors and pumps.
13. Exposed pipe, pipe hangers and supports, heat exchangers, tanks, piping and equipment insulation, plumbing and ductwork, motor shafts and mechanical equipment within garage and central plant rooms. Painting work excludes similar equipment located in mechanical fan (AHU Equipment) rooms.
14. All metal grilles, except anodized aluminum, unless otherwise indicated.
15. Exposed conduit, raceway, boxes, switchgear and electrical cabinets, excluding items located in mechanical fan (AHU Equipment) rooms.
16. Items normally requiring painting or finishing, or which are indicated to be painted or finished.
17. Where an item is not specifically mentioned, paint same as similar adjacent materials or surfaces.

B. Make test patches to verify coating system compatibility and adhesion over existing coatings and surfaces.

C. Do not include painting of:
1. Prefinished or factory finished items (e.g., shop finished woodwork and casework, acoustic materials, and similar items).
2. Aluminum, copper, chromium and other plated finishes.
3. Concealed surfaces in concealed and inaccessible areas including furred-areas, pipe chases, duct shafts, and similar spaces.
4. Operating parts of fire protection, plumbing, mechanical, and electrical equipment, including sensing devices, motor and fan shafts, and sprinkler heads.
5. Code required labels and nomenclature plates.

6. Exposed data and communication wiring and wiring devices.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 03 30 00 "Cast-in-Place Concrete."
2. Section 04 20 00 "Unit Masonry" for loose lintels, anchor bolts, and other items built into unit masonry.
3. Section 05 12 00 "Structural Steel Framing" for shop priming of steel framing substrates.
4. Section 05 31 00 "Steel Decking" for touch-up painting of steel decking welds.
5. Section 05 50 00 "Metal Fabrications" for shop priming of metal fabrication substrates.
6. Section 06 40 00 "Architectural Woodwork" for shop finishing of woodwork items.
7. Section 07 62 00 "Sheet Metal Flashing and Trim" for factory coil-coated materials.
8. Section 07 70 00 "Roof Accessories and Specialties."

1.4 DEFINITIONS

A. Painting and Coating Systems: Include coating system materials such as primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats. Paint and coating work includes surface preparation and cleaning, primer touch-up of shop primed items, repair of existing coatings (including barrier coats required to properly apply new coating systems), field priming and painting exterior and interior material, equipment and appurtenances.

B. Gloss Levels:
1. Gloss Level G1 (Traditional Matt Finish – Flat): Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
2. Gloss Level G2 (Velvet): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
3. Gloss Level G3 (Traditional Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
4. Gloss Level G4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
5. Gloss Level G5 (Traditional Semi-Gloss): 35 to 70 units at 60 degrees, according to ASTM D 523.
6. Gloss Level G6 (Traditional Gloss): 70 to 85 units at 60 degrees, according to ASTM D 523.
7. Gloss Level G7 (High Gloss): More than 85 units at 60 degrees, according to ASTM D 523.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.
5. Resubmit samples until required color sheen and texture are approved.

D. Application Schedule: Submit a schedule of paint system exposure, substrates and painting manufacturer's product data for barrier, prime, intermediate and topcoats, application instructions and application equipment recommended by painting manufacturer for application methods scheduled. For each product indicated, include the following:
   1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
   2. VOC content.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.7 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected 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 paint system specified in Part 3.
      a. Vertical and Horizontal 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.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Quality Grade: Provide manufacturer's best quality trade sale paint material of coating types specified. Use only material Manufacturer’s containers with intact labels with product identification.

C. Coating Systems: Provide primers, finish coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.

D. Color Designations and Selections: Subject to compliance with requirements, names used to designate colors are not intended to imply that manufacturers or products named are required to the exclusion of specified products of other manufacturers. Match colors indicated by reference to manufacturer's standard color designations.

E. Pigments: Use color pigments that are pure, non-fading, suitable for substrates and service indicated. Lead content in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non-volatile (dry-film) of paint by weight. This limitation is extended to interior surfaces and those exterior surfaces, such as stairs, decks, porches, railings, windows, and doors that are readily accessible to children under 7 years of age.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.9 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Coating Systems Products: Subject to compliance with requirements, provide products of one of the following for each substrate indicated:
1. Benjamin Moore & Co.(Moore)
2. PPG Paints. (formally Pittsburg Paints & Glidden Professional (GP)
3. Pratt & Lambert (P & L)
4. Sherwin-Williams Company (The) (S-W)
5. Behr Process Corporation (Behr)

B. Basis of Design: Refer to color schedule for Basis of Design paint selection.

2.2 PAINT, GENERAL

A. Material Compatibility:
1. Provide materials for use within each paint substrate system that are 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 coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated

B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

C. Low-Emitting Materials: Interior paints and coatings 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. Colors: As indicated in a color schedule.

2.3 EXTERIOR PAINTING SYSTEMS AND MATERIALS

A. Exterior Ferrous Metal:
1. Latex Semi-Gloss Enamel: 2 finish coats over primer.
   a. Primer: Rust Inhibitive Latex Primer.
      1) PPG: Devflex 4020PF Direct to Metal Primer & Flat Finish
      2) Benjamin Moore: Acrylic Metal Primer M04
      3) Sherwin Williams: Pro Industrial Pro Cryl Universal Primer B66W310
      4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
   b. First and Second Finish Coats: Exterior Semi-Gloss Latex Enamel.
      1) PPG: Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel
      2) Benjamin Moore: DTM Acrylic Semi-Gloss M29
      3) Sherwin Williams: Pro Industrial 0 VOC Acrylic Semi-Gloss
      4) Behr: Direct To Metal Semi-Gloss Paint 3200

B. Exterior Non-Ferrous Metal (Zinc Coated Steel and Aluminum):
1. Latex Semi-Gloss Enamel: 2 finish coats over primer.
   a. Primer: Latex Galvanized Metal Primer.
      1) PPG: Devflex 4020PF Direct to Metal Primer & Flat Finish
      2) Benjamin Moore: Acrylic Metal Primer M04
      3) Sherwin Williams: Pro Industrial Pro Cryl Universal Primer B66W310
      4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
   b. First and Second Finish Coats: Exterior Semi-Gloss Latex Enamel.
      1) PPG: Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel
      2) Benjamin Moore: DTM Acrylic Semi-Gloss M29
      3) Sherwin Williams: Metalatex Semi-Gloss Enamel B42W110
      4) Behr: Direct To Metal Semi-Gloss Paint 3200

C. Exterior Concrete:
1. Acrylic Low Luster (Flat) Elastomeric Masonry Coating: 2 coats over alkali resistant primer with total dry film thickness not less than 2 mils
   a. Primer Coat: Exterior Latex Flat Paint.
      1) PPG: Perma-Crete 4-603 Int/Ext Alkali Resistant Primer
      2) Benjamin Moore: Moorcraft Super Spec Exterior Flat 180
      3) Sherwin Williams: Loxon Masonry Primer A24W8300
      4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
   b. Finish Coats: Two rolled-on or brushed-on coats of elastic masonry coating.
      1) PPG: Perma-Crete Pitt-Flex 4-110 Elastomeric Costing
      2) Benjamin Moore: Moorlastic Acrylic Elastomeric Waterproof Coating Flat 056
      3) Sherwin Williams Loxon A24W350 Topcoat or Sherlastic Elastomeric A5-100
      4) Behr: Exterior Elastomeric Masonry Stucco & Brick Paint 68

2.4 INTERIOR PAINTING SYSTEMS AND MATERIALS

A. Interior Wood - Painted:
1. Latex Eggshell Low Odor Finish: 2 finish coats over primer.
   a. Primer: Latex-Based Interior Low-Odor White Primer.
      1) PPG: Seal Grip 17-921 Latex Primer
      2) Benjamin Moore: Eco Spec Interior Latex Primer Sealer 231
      3) Sherwin Williams: Pro Green 200 Low Odor VOC Primer B28W600
      4) Behr: Premium Plus All-In-One Primer & Sealer 75

b. First and Second Finish Coats: Latex-Based Interior Eggshell Enamel.
   1) PPG: Ultra Hide 250 1402 Eggshell (Pure Performance 9-300 Eggshell 0VOC)
   2) Benjamin Moore: Eco Spec Interior Latex Eggshell Enamel 223
   3) Sherwin Williams: Pro Green 200 Low Odor VOC Eg-Shell B20W651
   4) Behr: Behr Pro i300 Interior Eggshell 330

B. B. Interior Ferrous Metal:
   1. Latex Semi-Gloss Low Odor Finish: 2 finish coats over primer.
      a. Primer: Latex-Based Interior Low-Odor White Primer.
         1) PPG: Speedhide 6-2 Interior Latex Sealer
         2) Benjamin Moore: Eco Spec Interior Latex Primer Sealer 231
         3) Sherwin Williams: Pro Green 200 Low Odor Low VOC Primer B28W600
         4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
      b. First and Second Finish Coats: Latex-Based Interior Semi-Gloss Enamel.
         1) PPG: Speedhide 6-500 Semi-Gloss (Pure Performance 9-500 Semi Gloss 0VOC)
         2) Benjamin Moore: Eco Spec Interior Latex Semi Gloss 224
         3) Sherwin Williams: Pro Green 200 Latex Semi-Gloss B31W651
         4) Behr: Behr Pro i300 Interior Semi-Gloss 370

C. Interior Non-Ferrous Metal (Zinc Coated Steel and Aluminum):
   1. Latex Semi-Gloss Low Odor Finish: 2 finish coats over primer.
      a. Primer: Latex-Based Interior Low-Odor White Primer.
         1) PPG: Devflex 4020PF Direct to Metal Primer & Flat Finish
         2) Benjamin Moore: Eco Spec Interior Latex Primer Sealer 231
         3) Sherwin Williams: Pro Industrial Pro Cryl Universal Primer B66W310
         4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
      b. First and Second Finish Coats: Latex-Based Interior Semi-Gloss Enamel.
         1) PPG: Ultra Hide 250 1406 Semi-Gloss
         2) Benjamin Moore: Eco Spec Interior Latex Semi Gloss 224
         3) Sherwin Williams: Pro Green 200 Latex Semi-Gloss
         4) Behr: Behr Pro i300 Interior Semi-Gloss 370
   2. Primer/Waterborne Dryfall Topcoat (Interior Exposed Conduit, Electrical Boxes, Piping, Ductwork, Hangers and Hanger Wire, and Steel Deck):
      a. Surface Preparation: Solvent clean in accordance with SSPC SP1. Use clean tack cloth. All surfaces must be clean and dry.
      b. Primer: Water based metal primer or alkyd metal primer tinted to match topcoat.
         1) PPG: Devflex 4020PF Direct to Metal Primer & Flat Finish
         2) Benjamin Moore: Universal Metal Primer M07
         3) Sherwin Williams: Pro Industrial Pro Cryl Universal Primer B66W310
         4) Tnemec: Spra-Saf EN Series 30
         5) Behr: Premium Plus Multi-Surface Primer & Sealer 436
      c. Waterborne Acrylic Dryfall Finish: Provide one sprayed on coat of one of the following:
         1) PPG: Speedhide Super Tech Interior Dry-Fog Flat Latex 6-723XI
         2) Benjamin Moore: Sweep-Up Spray Latex Flat M53
         3) Sherwin Williams: Waterborne Acrylic Dryfall B42W2 (SG)
         4) Tnemec: Spra-Saf EN Series 30
         5) Behr: Behr Pro Dryfall 890 Flat White Base, 891 Flat Black

D. Interior Concrete Masonry Units:
   1. Acrylic Epoxy Gloss Finish: 1 finish coat over filled surface with a total dry film thickness not less than 2.0 mils, excluding block filler.

a. Filler Coat: High-performance latex block filler tinted to match topcoat. Apply at a rate to ensure complete coverage with pores filled.
   1) PPG: Speedhide Int/Ext 6-15 Acrylic Block Filler
   2) Benjamin Moore: Latex Block Filler M88
   3) Sherwin Williams: Heavy Duty Block Filler (B42W46)
   4) Behr: Behr Pro Block Filler Primer 50
b. Finish Coat: Two Part Low-Odor Acrylic Epoxy.
   1) PPG: Pitt-Glaze WB 16-551 High Solid Acrylic Epoxy; 2.25 - 2.7 mils DFT. VOC: Maximum 1.39 lb. /gal.
   2) Benjamin Moore: Acrylic Epoxy Coating M43/M44; 1.5 mils DFT/coat VOC: 1.86 lb. /gal
   3) Sherwin Williams: Water Based Epoxy (B70-200 Series) VOC: Maximum 1.50 lb. /gal.
   4) Behr: Behr Pro Pre-Catalyzed Waterborne Epoxy Semi-Gloss HP150; 1.5-2.0 mils DFT; VOC: <10 g/L

E. Interior Gypsum Drywall Systems:
1. Egg-Shell Prime Coat/Water Based Epoxy Topcoats (Wall Areas): 2 finish coats over primer.
   a. Primer: Waterborne epoxy, acrylic latex, or alkyd metal primer tinted to match topcoat.
      1) Sherwin Williams: ProMar 200 Latex Primer
         a) VOC – Lb./Gal: 0.71
         b) Dry Film Thickness – Mils: 1.0 to 1.1
   b. Finish Coats: Two component low-odor acrylic epoxy. Provide two individual sprayed or rolled on coats with minimum 4 hour curing prior to recoating.
      1) Sherwin Williams : B73-360/B73v300 Series
         a) VOC – Lb./Gal: 1.5
         b) Dry Film Thickness – Mils: 2.5 to 3.0
      2) Tnemec Series 114 H. B.
         a) VOC – Lb./Gal: 1.88 to 2.20
         b) Dry Film Thickness – Mils: 4.0 to 6.0
      3) Behr: US Coatings AquaGrip 2600 Water Based Epoxy Semi-Gloss
         a) C – Lb./Gal: .8
         b) Dry Film Thickness – Mils: 2.0 to 5.0
2. Cut Shellac Varnish Sealer or Alkyd Based Wall Primer (Wall Areas to Receive Wall Covering): 1 primer coat with a dry film thickness of 0.9 mils.
   a. Primer: Cut Shellac Varnish or Latex or Alkyd Primer/Sealer & Vapor Barrier.
      1) PPG : 17-21 Seal-Grip Acrylic Latex Wall Primer/Sealer
      2) Benjamin Moore: Moore's Wall-Grip 2
      3) Sherwin Williams: PrepRite PreWallcovering Primer B28W8980
      4) Behr: Premium Plus All-In-One Primer & Sealer 75

F. Interior Plaster:
1. Latex Lusterless (Flat) Emulsion Finish: 2 coats.
   a. Primer and Finish Coats: Latex Interior Flat Paint
      1) PPG: 6-70 Speedhide Latex Flat Wall Paint
      2) Benjamin Moore: Moorcraft Super Spec Latex Flat 275
      3) Sherwin Williams: ProMar 200 Latex Flat Wall Paint B30W200 Series
      4) Behr: Behr Pro i300 Interior Flat 310

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   2. Masonry (Clay and CMU): 12 percent.
   3. Wood: 15 percent.
   4. Gypsum Board: 12 percent.
   5. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Plaster Substrates: Verify that plaster is fully cured.

E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.

F. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

G. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
   1. SSPC-SP 2, "Hand Tool Cleaning."
   2. SSPC-SP 3, "Power Tool Cleaning."
   3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
   4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of

shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:
1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations.
1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed in equipment rooms:
a. Equipment, including panelboards and switch gear.
1) Uninsulated metal piping.
2) Uninsulated plastic piping.
3) Pipe hangers and supports.
4) Metal conduit.
5) Plastic conduit.
6) Tanks that do not have factory-applied final finishes.
7) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material, and internal surfaces of metal

ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

2. Paint the following work where exposed in occupied spaces:
   a. Equipment, including panelboards.
      1) Uninsulated metal piping.
      2) Uninsulated plastic piping.
      3) Pipe hangers and supports.
      4) Metal conduit.
      5) Plastic conduit.
      6) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
      7) Other items as directed by Architect.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
   1. Contractor shall touch up and restore painted surfaces damaged by testing.
   2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION

10 10 00

VISUAL DISPLAY BOARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and the application of painting and coating systems on the following substrates.
   1. Factory assembled porcelain enamel on metal marker boards liquid chalk surface (LCS) visual display boards
   2. Factory assembled plastic impregnated cork tack boards.

1.3 RELATED WORK

A. Related Work of Other Sections:
   1. Section 06 10 00 – Rough Carpentry: Blocking and grounds.
   2. Section 09 21 16 – Gypsum Board Assemblies.
   3. Section 09 90 00 – Painting and Coating.

1.4 SUBMITTALS

A. Product Data: Submit product data for each type of visual display board required, schedule of types, finishes, sizes and locations, color charts and installation and maintenance instructions. Indicate accessories (if any) that are to be furnished with each unit.

B. Shop Drawings: Submit shop drawings for vertical bi-passing units that are drawn to scale and indicating size and arrangement of units, mounting details, and relationship to supporting and adjacent related work of other Sections.

C. Samples: Submit samples of metal finishes, approximately 2” x 4” in size. Review of samples will

D. be for color and texture only. Submit samples of each type of tackboard, trim, and accessories.

1.5 PROJECT CONDITIONS

A. Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Coordinate fabrication schedule with construction progress to avoid delay.

PART 2 PRODUCTS

2.1 PRODUCT AND MANUFACTURER

A. Porcelain Enamel on Metal Marker Boards: Subject to compliance with requirements provide Claridge factory built "LCS White Series 1, Type A" 24 gauge porcelain on steel on 7/16 two-

ply hardboard with 0.024 inch thick aluminum backing, with angle clip hangers 24 inches on center, top and bottom, or equivalent units by Alliancewall or Best-Rite as approved.

1. Sizes: Provide individual units 48” high by up to 144” long factory fabricated with one-piece writing surface. Refer to Drawings size, arrangements, and special surface requirements.
2. Trim and Accessories: Provide each board complete with 1-1/2” wide satin anodized aluminum trim, chalk trough, one box of assorted color markers, four #76 display hooks, one set of #76RB roller brackets, two #76 FG flag holders, finished end termination caps.
   a. Where Marker Boards are to be accompanied by an interactive short throw projector as part of an Electronic Marker Board system, trim and accessories shall be coordinated to be compatible with the projector.

B. Vinyl Plastic Impregnated Cork Tackboards: Subject to compliance with requirements provide Claridge factory fabricated "Fabricork 1380 Type C0", or equivalent units by Alliancewall or Best-Rite as approved.

1. Style and Sizes: Match marker board height for field butted neat appearance.
2. Construction: Construct tackboards in three-ply laminated construction; facing sheet of 1/4” thick vinyl plastic impregnated cork; 1/4" thick hardboard or plywood core; 0.015" aluminum sheet, or minimum 0.016" (0.4 mm) thick galvanized steel sheet, or minimum 0.013" (0.3 mm) thick random porcelain coil backing sheet.
3. Color: As selected by Architect from full range of available colors
4. Trim: Provide complete with 1-1/2” wide satin anodized aluminum trim.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that substrates are properly prepared to receive visual display boards. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Locate units and accessories where shown or scheduled, using mounting methods of type described and in compliance with manufacturer's instructions.

3.2 INSTALLATION

A. Layout and install the work level, plumb and at height and margins indicated, free from distortion or other defects of appearance.

B. Complete installation free of scratches, dents, nicks, discolorations, and other defects in materials or workmanship that cause display board work to become unserviceable or objectionable in appearance.

C. Attach units to wall surfaces using mounting clips that are shipped with the display unit manufacturer to attach units to wood blocking in the substrates indicated. Adhesive attachment is not permitted

D. Verify that all accessories are installed as required for each unit.

3.3 CLEANING AND PROTECTION

A. At completion of the installation, clean soiled display unit surfaces in accordance with the manufacturer's instructions.

B. Protect units from damage until acceptance by Owner.

END OF SECTION

10 12 00

DISPLAY CASES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes Illuminated display cases.

B. Related Sections:
1. Section 10 13 00 "Directories" for boards with changeable messages or changeable letters.
2. Division 26 Sections for wiring and other electrical work associated with illuminated directories and display cases.

1.3 DEFINITIONS

A. Bulletin Board: Tackable visual display surface or tackboard enclosed in a display case.

B. Display Case: Glazed cabinet with [adjustable shelves] [visual display surface background and adjustable shelves].

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for display cases.

B. Shop Drawings: For display cases. Include plans, elevations, sections, details, and attachments to other work.
1. Show location of seams and joints in visual display surfaces.
2. Include sections of typical trim members.
3. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes, and as follows:
1. Actual sections of visual display surfaces.
2. Section of header panel for color selection.

D. Samples for Verification: For each type of product indicated.
1. Visual Display Surface: Not less than 8-1/2 by 11 inches (215 by 280 mm), mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: 6-inch- (152-mm-) long sections of each trim profile

E. Delegated-Design Submittal: For display cases indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For visual display surfaces, operating hardware, and illuminated units] to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain display cases from single source from single manufacturer.

B. 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. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

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. Preinstallation Conference: Conduct conference at Project site.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install display cases 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.

B. Field Measurements: Verify actual dimensions of openings for display cases by field measurements before fabrication.

PART 2 PRODUCTS

2.1 MATERIALS

A. Hardboard: ANSI A135.4, tempered.

B. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.

C. Fiberboard: ASTM C 208.

D. Hardwood Plywood: HPVA HP-1 made with adhesive containing no urea formaldehyde.

E. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish.

F. Plastic-Impregnated Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto burlap backing; with washable vinyl finish and integral color throughout.

G. Extruded-Aluminum Bars and Shapes: ASTM B 221 (ASTM B 221M), Alloy 6063.

H. Aluminum Tubing: ASTM B 429, Alloy 6063.

I. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering, and 6 mm thick unless otherwise indicated.

J. High-Pressure Plastic Laminate: NEMA LD 3.

K. Fasteners: Provide screws, bolts, and other fastening devices made from same material as items being fastened, except provide hot-dip galvanized, stainless-steel, or aluminum fasteners for exterior applications. Provide types, sizes, and lengths to suit installation conditions. Use security fasteners where exposed to view.

L. Adhesives: Manufacturer's standard product that complies 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."

2.2 DISPLAY CASE ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
1. A-1 Visual Systems.
2. AARCO Products, Inc.
3. ADP Lemco, Inc.
4. Best-Rite Manufacturing.
5. Claridge Products and Equipment, Inc.
6. Ghent Manufacturing, Inc.
7. Nelson-Harkins Industries.
8. Platinum Visual Systems; a division of ABC School Equipment, Inc.
9. Poblocki Sign Company.
10. PolyVision Corporation; a Steelcase company.
11. Tablet & Ticket Co. (The).

B. General: Factory-fabricated unit consisting of manufacturer's standard wall-mounted cabinet with tackboard assembly on back inside surface and operable glazed doors at front.

C. Aluminum-Framed Cabinet: Extruded aluminum]; with clear anodic finish.

D. Cabinet Corners: Square.

E. Glazed Hinged Doors: Tempered glass; set in frame matching cabinet material and finish. Equip each door with full-height continuous hinge and cylinder lock with two keys.
1. Thickness: Not less than 6 mm thick.
2. Number of Doors: As indicated on Drawings.

F. Illumination System: Concealed top-lighting system consisting of fluorescent-strip fixtures. Include lamps and internal wiring with single, concealed electrical connection to building system. Coordinate electrical characteristics with power supply provided.
1. Ballasts: Low-temperature, high-power-factor, low-energy, fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association standards and carry its label.

G. Tack Surface: Plastic-impregnated-cork tackboard assembly.

H. Width, Height, Depth and Mounting Height: As indicated on Drawings.

I. Mounting: Recessed.

2.3 FABRICATION

A. Fabricate display cases to requirements indicated for dimensions, design, and thickness and finish of materials.

B. Use metals and shapes of thickness and reinforcing to produce flat surfaces, free of oilcanning, and to impart strength for size, design, and application indicated.

C. Fabricate cabinets and door frames with reinforced corners, mitered to a hairline fit, with no exposed fasteners.

D. Fabricate exterior units with vents to permit evaporation of moisture trapped inside.

E. Fabricate shelf standards plumb and at heights to align shelf brackets for level shelves.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical 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.

2.5 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine walls, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power system to verify actual locations of connections before installation of illuminated units.

C. Examine walls and partitions for proper backing for display cases.

D. Examine walls and partitions for suitable framing depth if recessed units will be installed.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for display cases as required by type and size of unit.

3.3 INSTALLATION

A. General: Install units in locations and at mounting heights indicated on Drawings. Keep

perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Recessed Display Cases: Attach units to wall framing with fasteners at not more than 16 inches (400 mm) o.c. Attach aluminum trim over edges of recessed display cases and conceal grounds and clips. Attach trim with fasteners at not more than 24 inches (600 mm) o.c.

C. Comply with requirements in Division 26 for connecting illuminated display cases.
   1. After installation is complete, install new lamps.

D. Install display case shelving level and straight.

3.4 ADJUSTING AND CLEANING

A. Adjust doors to operate smoothly without warp or bind and so contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION

10 14 00

SIGNAGE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Exterior marquee signs.
2. Exterior handicapped parking signs and sign supports
3. Interior painted photo polymer panel signs.
4. Vinyl die cut signs.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Division 10 Section "Directories" for building directories.
2. Division 14 Section "Hydraulic Elevators" for code-required elevator signage.
3. Division 23 Section "Mechanical Identification" for labels, tags, and nameplates for mechanical equipment.
4. Division 26 Sections for electrical service and connections for illuminated signs.
5. Division 26 Section "Electrical Identification" for labels, tags, and nameplates for electrical equipment.
6. Division 26 Section "Interior Lighting" for illuminated Exit signs.

1.4 DEFINITIONS

A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.5 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details for signs.
1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
2. Provide message list, typestyles, graphic elements, including tactile characters and Braille, and layout for each sign.
3. Wiring Diagrams: Power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's color charts consisting of actual units or sections of units showing the full range of colors available for the following:
1. Aluminum.
2. Acrylic sheet.

3. Die-cut vinyl characters and graphic symbols. Include representative samples of available typestyles and graphic symbols.

D. Samples for Verification: For each of the following products and for the full range of color, texture, and sign material indicated, of sizes indicated:
1. Plaque Casting: 6 inches (150 mm) square including border.
2. Dimensional Characters: Full-size Samples of each type of dimensional character (letter, number, and graphic element).
3. Acrylic Sheet: 8 by 10 inches (200 by 250 mm) for each color required.
4. Panel Signs: Not less than 12 inches (305 mm) square including border.
5. Vinyl die cut signs.
6. Accessories: Manufacturer's full-size unit.

E. Sign Schedule: Use same designations indicated on Drawings.

F. Qualification Data: For Installer and fabricator.

G. Maintenance Data: For signs to include in maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. 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 inservice performance.

C. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.

D. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

E. 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.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate placement of anchorage devices with templates for installing signs.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Deterioration of metal and polymer finishes beyond normal weathering.
   b. Deterioration of embedded graphic image colors and sign lamination.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MATERIALS

A. Aluminum Sheet and Plate: ASTM B 209(ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.

B. Aluminum Extrusions: ASTM B 221(ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.

C. Cast Acrylic Sheet: Provide clear cast (not extruded or continuous cast) methacrylate plastic sheet with a minimum flexural strength of 16,000 psi, ASTM D 790, minimum allowable continuous service temperature of 180-degrees F (82-degrees C); in sizes and thicknesses indicated; “Plexiglas” by Rohm and Haas, Acrylite GP by Cyro Industries, or “Lucite L” by General Electric.

D. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).

E. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils(0.076 mm) with pressure-sensitive adhesive backing, suitable for exterior applications.

F. Polyurethane Enamel: Provide polyurethane enamel consisting of ultra-violet inhibitors which are lightfast, weather, abrasion and wear resistant. Provide one of the following:
   1. Chemglaze, Hughson Chemical Division, Lord Corp.
   2. Imron, DuPont de Nemours & Co.

G. Steel Pipe: ASTM A53, Type EF, or G at fabricators option, Grade A, black finish, unless otherwise shown as galvanized standard weight, (Schedule 40).

2.2 MARQUEE SIGNS

A. Basis of Design Product: Subject to compliance with requirements, provide Model AF-3500 (76- feet minimum viewing distance) Monochrome Outdoor Full-Matrix Display manufactured by Daktronics, Inc., Brookings, SD; (Tel) 888-325-7446, or Architect approved equal:

B. Technical Specifications: Provide exterior marquee signs as follows:
   1. Cabinet Enclosure Material: Aluminum sheet, Minimum 0.060 thick.
   2. Mounting: Concealed studs, noncorroding for substrates encountered.
   3. Color: As selected by Architect from manufacturer’s full range.
   4. Character Height: (*) 9 or 10 inches (seven (7) pixel font) (*) with min. 3 lines of text.
   5. Pixel Pitch: 0.78 inch center to center.
   6. Resolution: (*) 34mm, 82 pixels per square foot.
   7. Color Capability: (*) 4,096 shades of red and amber (*) available. Confirm red or amber with HISD Project Manager.
   8. LEDs per Pixel: One (1) red (*) or two (2) amber.
   9. Estimated LED Lifetime: 100,000+ hours.
   10. Horizontal Viewing Angle: 90 degrees (45 degrees left and right)
   11. Vertical Viewing Angle: 40 degrees (20 degrees up and down)
   12. Contrast Enhancement: (*) Non-reflective black louvers.

13. Cabinet Configuration: Front access, ventilated single cabinet.
14. Graphic Capability: Text, graphics, logos, basic animation, multiple font styles and sizes.
15. Control Software: Venus® 1500 (*) Version 3.X software.
16. Power: 120/240 VAC single phase.
17. Display Dimming: 64 levels (automatic or manual control)
18. Communication Options: Variety of direct connect or wireless options available.
19. Matrix Size: 48 x 112
20. Cabinet Size: (*) 3'-10" high x 7'-10" wide x 8" deep.
21. Weight: 300 lbs. per single face.
22. Minimum viewing distance: 76'
23. Maximum Watts per Face (Red): 760
24. Number: One double-sided marquee signs.
25. Location: As shown on drawings.
26. Plaque Schedule: Refer to Drawing for size, details, message, finishes and locations required.

2.3 INTERIOR PANEL SIGNS

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 Sign Systems, Inc.
2. Advance Corporation; Braille-Tac Division.
3. Allen Industries Architectural Signage
4. Allenite Signs; Allen Marking Products, Inc.
5. APCO Graphics, Inc.
6. ASI-Modulex, Inc.
7. Best Sign Systems Inc.
8. Bunting Graphics, Inc.
9. Fossil Industries, Inc.
10. Gemini Incorporated.
11. Grimco, Inc.
12. Innerface Sign Systems, Inc.
13. InPro Corporation
14. Matthews International Corporation; Bronze Division.
15. Mills Manufacturing Company.
16. Mohawk Sign Systems.
17. Nelson-Harkins Industries.
18. Seton Identification Products.
19. Signature Signs, Incorporated.
20. Supersine Company (The)

B. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch(1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
1. Etched Photo Polymer Panel Signs: Provide photo polymer plaques with Helvetica Medium 5/8-inch high text, 4-inch high symbols and Grade 2 Braille, in sizes, arrangements and colors indicated. Provide panel signs with raised copy, pictorial symbols and Braille characters raised at least 1/32-inch above panel surface and complying with the requirements indicated and with the Americans with Disabilities Act of 1990, with amendments.
2. Edge Condition: Square cut.
3. Corner Condition: Round to radius indicated.
4. Mounting: Unframed.
   a. Wall mounted with two-face tape and adhesive.

5. Custom Paint Colors: Match Pantone color matching system.
6. Color: As selected by Architect from manufacturer's full range.
7. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface with contrasting colors.

2.4 EXTERIOR HANDICAPPED PARKING SIGNS AND VAN ACCESSIBLE SIGNS

A. Basis of Design Product and Manufacturer: Provide Best Sign Systems, Montrose, CO, (Tel) 800-235-2378, Model SS01 "Reserved Parking with Handicapped Symbol" sign, size 12" x 18", and Model SS52 "Van Accessible" sign, size 12" x 6", each fabricated from minimum 0.042" (1.0 mm) thick bonderized steel with white baked enamel background and silk screened blue enamel with white symbol, or Bradley B-959 18 x 12 94175 with B-959 6 x 12 91387 distributed by Bauer Visual Graphics, Inc., Pasadena, TX (Tel) 713-473-5241, or equivalent approved. Provide complete with 2-3/8" OD x 10' long galvanized steel posts and brackets for mounting.

B. Schedule: Refer to Drawings for sign types and locations required.

2.5 INTERIOR VINYL DIE-CUT FILM

A. Provide 1-inch high, upper case, Helvetica Medium vinyl die-cut letters fabricated from, opaque non-reflective vinyl film, 0.0035-inch minimum thickness, with pressure sensitive adhesive backing, suitable for exterior and interior applications as follows.

B. Interior Vinyl Die Cut Film Schedule: Refer to Drawing for size, details, message, finishes and locations required.

2.6 ACCESSORIES

A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

B. Adhesives and Tapes: Provide General Electric GE 1200 sealant, translucent SCS 1201 or equivalent translucent silicone sealant accepted by Architect. Provide 1/16-inch thick foam tape for temporary support of sign units.

2.7 FABRICATION

A. General: Provide manufacturer's standard signs of configurations indicated.
1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.8 FINISHES, GENERAL

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. 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.

2.9 ALUMINUM FINISHES

A. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
   1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils(0.04 mm), medium gloss.

2.10 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

B. Factory Priming for Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
   1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromatefree, universal primer, selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

C. 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(0.05 mm).

2.11 ACRYLIC SHEET FINISHES

A. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

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 work.

B. Verify that items, including anchor inserts are sized and located to accommodate signs.

C. Examine supporting members to ensure that surfaces are at elevations indicated or required

to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Confirm that substrate finishes have been completed and cured sufficiently to receive sign materials.

B. Confirm that substrates to receive signs are clean, free of deleterious substances that would detract from the neat appearance of high quality sign work, or that would interfere with the durable installation of sign work.

C. Do not proceed with installation of sign work until unacceptable conditions have been corrected and substrates are ready to receive sign work.

3.3 INSTALLATION

A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
   1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.

B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
   1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
   2. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
   3. Signs Mounted on Glass: Provide matching opaque plate on opposite side of glass to conceal mounting materials.

C. Marquee Sign: Mount plaques using standard fastening methods to comply with manufacturer's written instructions for type of wall surface indicated.
   1. Concealed Mounting: Mount plaques by inserting threaded studs into tapped lugs on back of plaque. Set in predrilled holes filled with quick-setting cement.

3.4 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

END OF SECTION

10 21 00

TOILET PARTITIONS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes furnishing and installing the following:
1. Floor supported overhead braced solid phenolic plastic toilet compartments and wall mounted screens.
2. Heavy-duty institutional stainless steel hardware.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 06 10 00 – Rough Carpentry: Wood blocking.
2. Section 09 21 16 – Gypsum Drywall Assemblies.
3. Section 09 30 00 – Tiling.
4. Section 10 28 13 – Toilet Accessories.

1.4 SUBMITTALS

A. Product Data: Submit product data for each type of compartment and screen required, schedule of types, finishes, sizes and locations, color charts and installation and maintenance instructions. Indicate accessories that are to be furnished with each unit.

B. Shop Drawings: Submit shop drawings for compartment and screen units that are drawn to scale and indicating size and arrangement of units, mounting details, and relationship to supporting and adjacent related work of other Sections.

C. Samples: Submit samples of solid plastic finishes, approximately 4” x 4” in size. Review of samples will be for color and texture only. Submit samples of each type of hardware, trim, and accessory.

1.5 QUALITY ASSURANCE

A. Material Quality Assurance: Obtain solid phenolic plastic only from a source with sufficient capacity of consistent color range and texture required for this Project. Solid phenolic plastic shall match approved sample on file in the Architect's office.

B. Qualifications of Fabricator: Only a firm that has had a minimum of 5 years successful experience in the design and fabrication of solid phenolic plastic compartment work similar to work required for this Project will be acceptable. Fabricator must have sufficient production capacity to design, fabricate, transport and deliver required solid phenolic plastic compartment work, anchorage and support work without causing delay in the Work. Fabricate solid phenolic plastic compartment work only at a plant engaged in producing similar units.

C. Dimension Coordination: Coordinate and verify by measurement at the Project Site, dimensions affecting solid phenolic plastic compartments and related work. Submit written notification of field dimensions and conditions that vary from requirements indicated on the Drawings, approved shop drawings, in conflict with ADA and TAS requirements, or are detrimental to proper and timely installation of related work. Where conflicts occur, obtain determination from Architect prior to fabrication of solid phenolic plastic compartment and screen work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect stone during storage and construction against moisture, soiling, staining, and physical damage.

B. Handle solid phenolic plastic material to prevent chipping, breakage, soiling, or other damage. Lift with wide-belt type slings wherever possible; do not use wire rope or ropes containing tar or other substances that might cause staining.

C. Store materials on wood skids or pallets; distribute weight evenly and to prevent breakage or warping of components. Protect stored compartments from weather with waterproof, nonstaining covers or enclosures, but allow air to circulate around packaging.

1.7 JOB CONDITIONS

A. Installer must review installation procedures and coordination with other work, with Contractor, and other contractors and subcontractors whose work will be affected by compartment work.

1.8 WARRANTY

A. Furnish 10 year limited warranty for panels, doors, and stiles against breakage, corrosion, delamination, and defects in factory workmanship.

B. Furnish one-year guarantee against defects in material and workmanship for stainless steel door hardware and mounting brackets.

PART 2 PRODUCTS

2.1 PRODUCT AND MANUFACTURER

A. Subject to compliance with requirements, provide “1182.67 Duraline Series” floor supported – overhead braced compartments” and “1185 Duraline Series” wall mounted urinal screen units produced by Bobrick Washroom Equipment, or equivalent by Sanymetal, Accurate Partitions, Global Steel Products, Ampco, or Tex Lam Mfg., Inc.

2.2 COMPONENTS / MATERIALS

A. Stiles, Panels, Doors, and Screens:
   1. Solid phenolic material with high-pressure matte finish melamine surfaces fused to core. Edges shall be black. Solid phenolic material shall meet National Fire Protection Association Class A, Uniform Building Code Class I, ASTM E-84 Fire Resistance Standards; flame spread 20, smoke density 95. Brown edges shall not be acceptable. Color and pattern as selected by Architect from full range of available standard colors.
   2. Finish Thickness:
      a. Stiles and doors shall be 3/4-inch (19-mm) thick.
      b. Panels and benches shall be 1/2-inch (13-mm) thick.

B. Hardware, General:
   1. All hardware to be 18-8, type 304 stainless steel with satin finish.
   2. All hardware shall be concealed inside compartments with the exception of outswinging doors.
   3. Hardware of chrome plated "Zamac" is unacceptable.

C. Latch:
   1. Sliding door latch shall be 16-gauge (1.6mm).
   2. Sliding door latch shall require less than 5-lb force to operate. Twisting latch operation will not be acceptable.
   3. Latch track shall be attached to door by theft resistant one-way stainless steel machine screws into factory installed metal inserts. Fasteners secured directly into the core are not acceptable.
   4. Latch handle shall have rubber bumper to act as a doorstop.
   5. Latch shall allow door to be lifted over 11-gauge (3-mm) keeper for emergency access.
   6. Metal to metal connection shall withstand a direct pull of over 1000-lbs per screw.

D. Hinges:
   1. Continuous stainless steel hinges shall be installed on the interior side of each door for the full height of the door. Provide wrap around hinge design where doors are required to swing out. No integral hinges are permitted.
   2. Hinges shall be attached to door and stile by theft resistant one-way stainless steel machine screws into factory installed metal inserts. Fasteners secured directly into the core are not acceptable.
   3. Metal to metal connection shall withstand a direct pull of over 1000-lbs per screw.

E. Coat Hook: stainless steel coat hook shall project no more than 1-1/8-inch (29-mm) from face of door and shall be secured by theft resistant one-way stainless steel screws.

F. Mounting Brackets: Stainless steel mounting brackets shall be mounted inside compartment. Mounting brackets exposed on the exterior of the compartment will not be acceptable. Wall mounted urinal screen brackets shall be 11-gauge (3mm) double thickness.

G. Leveling Device: 3/8" x 1" (10 mm x 25 mm) steel bar shall be chromate treated and double zinc plated; bolted to base of solid phenolic stile.

H. Stile Shoe: One piece, 4-inch (102-mm) high, type 304, 22-gauge (0.8 mm) stainless steel with satin finish. Top shall have 90° return to stile.

I. Headrail (Overhead braced): Extruded anodized aluminum with satin finish.

2.3 FABRICATION

A. Complete fabrication, assembly, finish hardware application, and other work before shipment to the Project Site to maximum extent possible.

B. Take field measurements for work required to be fitted to other construction.

C. Fabricate each pilaster, divider, end, door, and screen panel from one piece of solid phenolic plastic only. Bevel edges 15 · from edge surface.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that concealed blocking and substrates are properly prepared to receive compartments and screens. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Locate units and accessories where shown or scheduled, using mounting methods of type described and in compliance with manufacturer's instructions.

3.2 INSTALLATION

A. Comply with manufacturer's instructions and mounting methods.

B. Layout and install the work level, plumb and at height indicated and with clearances of not more than 1/2" between pilasters and partitions and not more than 1" at walls, free of scratches, dents, nicks, discolorations, and other defects in materials or workmanship.

3.3 CLEANING AND PROTECTION

A. At completion of installation, promptly clean soiled surfaces in accordance with manufacturer's instructions.

B. Protect units from damage until acceptance by Owner.

END OF SECTION

10 28 00

TOILET ACCESSORIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes furnishing and installing toilet accessories at the locations indicated.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 09 21 16 – Gypsum Board Assemblies.
2. Section 09 30 00 – Tiling.
3. Section 09 90 00 – Painting.
4. Section 10 21 00 – Toilet Partitions.

1.4 SUBMITTALS

A. Product Data: Submit product data for each type of unit required.

B. Shop Drawings: Submit shop drawings for each type of unit required, including details of construction, finishes, fasteners, sizes and locations required.
1. Show mounting locations and mounting heights.
2. Show and relationship to framing, blocking, nailers and other related work.

1.5 PROJECT CONDITIONS

A. Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting.

B. Coordinate fabrication schedule with construction progress to avoid delay.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Refer to toilet accessory schedule in drawings for basis of design manufacturers and products. Subject to compliance with the Design/Performance and other requirements, equivalent systems by other manufacturers will be acceptable as approved by the architect.

B. Provide toilet accessories with brushed finish stainless steel except as noted.

C. Coordinate accessory keying and other requirements with Owner's Representative.
1. Include coordination of Owner Furnished items.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that substrates, rough openings, and blocking are properly prepared to receive accessory units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Layout and securely install accessories and cabinets to supporting structure at locations indicated, level, plumb, at proper heights, and at margins indicated.

B. Complete installation free of scratches, dents, nicks, discolorations, and other defects in materials or workmanship that cause accessory work to become unserviceable or objectionable in appearance.

3.3 CLEANING AND PROTECTION

A. At completion of the installation, remove protective coverings and clean soiled accessory unit surfaces in accordance with the manufacturer's instructions.

B. Protect units from damage until acceptance by Owner.

END OF SECTION

10 44 00

FIRE EXTINGUISHERS AND CABINETS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes furnishing and installing portable fire extinguishers and fire extinguisher cabinets at the locations indicated.

B. Related Sections:
1. Division 04 Section – Unit Masonry.
2. Division 09 Section – Gypsum Board Systems.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
1. Fire Extinguishers: Include rating and classification.
2. Fire-Protection Cabinets: Include door hardware, cabinet type, trim style, panel style, and details of installation.

B. Samples: For each exposed cabinet finish.

C. Maintenance data.

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.

C. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

A. Apply vinyl lettering on field-painted fire-protection cabinets after painting is complete.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Failure of hydrostatic test according to NFPA 10.
b. Faulty operation of valves or release levers.
2. Warranty Period: Six years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 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:
   1. Sheet: ASTM B 209.
   2. Extruded Shapes: ASTM B 221.

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 PORTABLE FIRE EXTINGUISHERS

A. Available Manufacturers:
   1. Ansul Incorporated.
   2. JL Industries, Inc.
   3. Kidde Fyrnetics.
   4. Larsen's Manufacturing Company.
   5. Potter Roemer; Div. of Smith Industries, Inc.

B. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet indicated.
   1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

C. Multipurpose Dry-Chemical Type in Steel Container (Type FE-1): UL-rated 2-A:10-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

D. Multipurpose Dry-Chemical Type in Steel Container (Type FE-2): UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 FIRE-PROTECTION CABINET (FEC-1)

A. Basis-of-Design Product: Provide fire extinguisher cabinets where indicated, of the following types and suitable size for housing fire extinguishers of types and capacities indicated. The following are the type and sizes of cabinets required for this Project. Equivalent units produced by J. L. Industries, Ansul Fire Protection, or Potter-Roemer, Inc. will be acceptable as approved:
   1. Manufacturer's standard 18 gage enameled steel flat-trim, semi-recessed box and solid flush door; Larsen's Model No. FS-SS2409-R4, 24" H x 9-1/2" W x 6" D, with 5/16" flat trim, and black die-cut vinyl "FIRE EXTINGUISHER" lettering vertical on door.

B. Cabinet Construction: Fire-rated.

C. Maximum Projection from Face of Wall to outermost portion of Fire Protection Cabinet: 4”

2.4 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. Weld joints and grind smooth.
   1. 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.

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 INSTALLATION

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 recessed cabinets will be installed.

C. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units.

D. Prepare recesses for fire-protection cabinets as required by type and size of cabinet and trim style.

E. Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

F. Fire-Protection Cabinets: Fasten fire-protection 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 semirecessed fireprotection cabinets.
   2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

G. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

H. Identification: Apply vinyl lettering at locations indicated.

I. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

J. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair.

3.2 CLEANING AND PROTECTION

A. At completion of the installation, remove protective coverings and clean soiled accessory unit surfaces in accordance with the manufacturer's instructions.

B. Protect units from damage until acceptance by Owner.

END OF SECTION

10 73 00

ALUMINUM CANOPIES AND AWNINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes furnishing and installing:
1. Extruded Aluminum Sidewalk Canopies, footings, framing, and bracing.
2. Extruded Aluminum Awnings, framing and bracing to supporting structure.
3. Anchors, sealants within framing system and to related work.

1.3 RELATED WORK

A. Related Work of Other Sections:
1. Section 07 60 00 – Flashing and Sheet Metal.
2. Section 07 91 00 – Joint Sealants.
3. Section 09 90 00 – Painting and Coating
4. Division 26 Sections: Electrical lighting fixtures installed in canopies.
5. Section 32 13 13 – Concrete Paving.

1.4 PERFORMANCE REQUIREMENTS

A. Design, engineer, fabricate and install aluminum canopies, bracing and anchorage to withstand the following structural and wind loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each metal fabrication. Arrange for required design work to be performed by a professional engineer who is legally authorized to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated and that have resulted in successful installation of metal fabrications similar in material, design, and extent to those required for Project.

B. Structural Loads: Framing member sizes and wall thickness indicated are minimums and are for detailing only. Confirm framing member sizes, wall thicknesses, and need for internal reinforcements by analyzing Project loads and in-service conditions. Provide canopy framing member sizes as indicated, but not less than size and strengths required to meet or exceed the following criteria:
1. Wind Loads: Provide canopy systems, including anchorage, capable of withstanding wind-load design pressures calculated according to requirements of authorities having jurisdiction or the American Society of Civil Engineers' ASCE 7, "Minimum Design Loads for Buildings and Other Structures," 6.4.2, "Analytical Procedure," whichever are more stringent.
   a. Design Wind Speed: 137mph 3-Second Gust.
   b. Risk Category II.
   c. Exposure Category: C.

2. Deflection Normal to Wall Plane: Limited to 1/240 of clear span plus 1/4 inch or 3/4 inch, whichever is less.

C. Thermal Movements: Provide aluminum-framed canopy systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.5 SUBMITTALS

A. Product Data: Submit product data for each type and arrangement of aluminum canopy required, showing available finishes and color charts.

B. Shop Drawings: Submit shop drawings for each type and arrangement of aluminum canopy and awning. Include plans and details showing sizes, arrangements, connections and bracing, finishes, weatherproof light fixture mounting and unobtrusive electrical conduit routing and conduit support connections, sealants, counterflashings, and locations relative to related work.
1. Include canopy foundation designs and anchor systems as applicable.

C. Engineering Calculations: Submit structural engineering calculations, prepared, sealed, and signed by a registered Professional Engineer licensed in the State where the project is located. Submit calculations concurrently with shop drawings.
1. Include justification of all aluminum canopy members, bracing, connections, fasteners, and anchorage components for compliance with criteria established in the Design/Performance Requirements article of this Section.
2. Include magnitude of allowable structural deflections at all principle framing elements and the structural analysis of all connections.
3. Approval of calculations and shop drawings by the Engineer will not relieve the Contractor of any responsibilities for providing a system complying with the required performance requirements.
4. If the structural calculations indicate any deficiencies, provide items necessary to comply with the design/performance requirements as part of the work of this Section.

D. Samples: Include samples of required colors and finishes. Review of samples will be for color and texture only.

1.6 QUALITY ASSURANCE

A. Comply with the provisions of the following codes, standards and specifications, except as otherwise shown and specified.
1. AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings," including "Commentary of the AISC Specifications."
2. AISI "Specifications for the Design of Cold-Formed Steel Structural Members."
3. ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use."
4. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel," D1.2 “Structural Welding Code – Aluminum," and D1.3 "Structural Welding Code - Sheet Steel." Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.7 PROJECT CONDITIONS

A. Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Coordinate fabrication schedule with construction progress to avoid delay.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Aluminum Canopy System (Basis of Design): Subject to compliance with Design/Performance, and other requirements, Avadek, Houston, TX, (Tel) 713-944- 0988 is the basis of design required for this project, or equivalent produced by, in the sizes and arrangement indicated, or equivalent by Aluminum Techniques, or Ditt-Deck canopies produced by Dittmer Architectural Aluminum, Winter Springs, FL, (Tel) 800- 822-1755.
   1. Design and arrange roof deck and rigid bents to drain internally from deck to scuppers located in the canopy end corners as indicated away from pedestrian pathways.
   2. Provide Heliarc welded rigid bent supports as indicated with concealed fasteners at all other connections.
   3. Provide connection base plate detail permitting level and plumb installation of canopy for conditions shown.
   4. Anchors and Fasteners: AISI Type 302/304 stainless steel.

2.2 FABRICATION

A. Weld beams into 1-piece rigid bents in the manufacturer's shop. Rigidly install extruded structural ties in tops of all beams to serve as closures between draining deck sections.

B. Arrange extruded roof deck sections to interlock in a homogenous structural unit, with joint designed and fabricated into structurally rigid shape that is self-flashing.

C. Rigidly fasten interlocking joints with fastenings 2" o.c. Fastenings shall have minimum shear strength of 350 lb. each. Assemble roof deck on simple spans of 15' or more with camber sufficient to neutralize deflection caused by dead load of material and to provide positive drainage of the deck. No protruding ribs on the underside of the deck are permissible.

2.3 FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.

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.

C. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.

D. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 2605 and with coating and resin manufacturers' written instructions after fabrication.
   1. Color: To be chosen by architect from manufacturer’s standard range. Refer to drawings for more information.

PART 3 EXECUTION

3.1 INSTALLATION

A. Layout and securely install and brace work to supporting structure at locations indicated, level, plumb and at margins indicated to related work.

B. Install sealant and backup rod to a neat provide weatherproof seal to supporting structure. Refer to Section 07 62 00 – Sheet Metal Flashing and Trim for flashings and counterflashings and Section 07 91 00 – Joint Sealants for related work.

C. Complete installation free of scratches, dents, nicks, discolorations, and other defects in materials or workmanship that cause work to become unserviceable or objectionable in appearance.

D. Clean exposed metal surfaces to remove finger prints, excess sealants, dirt, and other contamination.

END OF SECTION

11 31 00

RESIDENTIAL APPLIANCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes residential appliances at locations scheduled on the Drawings.

B. Related Sections:
1. Section 06 10 00 – Rough Carpentry for built-in wood blocking.
2. Section 06 40 00 – Architectural Woodwork.
3. Section 07 92 00 – Joint Sealants.
4. Section 09 21 16 – Gypsum Board Assemblies.
5. Section 09 65 00 – Resilient Flooring.
6. Division 22 Sections for plumbing system rough-in.
7. Division 23 Sections for HVAC system rough-in.
8. Division 26 Sections for electrical system rough-in.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, dimensions, furnished accessories, and finishes for each appliance.

B. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.

C. Product Schedule: For appliances. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of appliance, from manufacturer.

C. Field quality-control reports.

D. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintains, within 40 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 residential appliances from single source and 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.
   2. ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.

E. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with Texas Accessibility Standards and the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

F. Preinstallation Conference: Conduct conference at Project site.

1.7 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.

B. Electric Range: Limited warranty including parts and labor for first year and parts thereafter for on-site service on surface-burner elements.
   1. Warranty Period: Two years from date of Substantial Completion.

C. Microwave Oven: Limited warranty including parts and labor for first year and parts thereafter for on-site service on the magnetron tube.
   1. Warranty Period: Two years from date of Substantial Completion.

D. Refrigerator/Freezer/Icemaker, Sealed System: Limited warranty including parts and labor for first year and parts thereafter for on-site service on the product and for the following:
   1. Sealed Refrigeration System: Five years from date of Substantial Completion.
   2. Other Components: Two years from date of Substantial Completion.

E. Dishwasher: Limited warranty including parts and labor for first year and parts thereafter for on-site service on the product.
   1. Warranty Period for Deterioration of Tub and Metal Door Liner: Five years from date of Substantial Completion.
   2. Warranty Period for Other Components: Two years from date of Substantial Completion.

F. Clothes Washer: Limited warranty including parts and labor for first year and parts thereafter for on-site service on the product.
   1. Warranty Period: Three years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 RESIDENTIAL APPLIANCES

A. Basis-of-Design Products:
   1. Refrigerator, General Electric GTE21GSHSS, stainless steel, top freezer, 21.2cu.ft., 33"x66.75"x34", ADA Compliant.

2. Large Countertop Microwave, General Electric JES2251SJ, stainless steel, 2.2cu.ft., 24"x13.75"x19.5", 1200 watts.
3. Electric Cooktop Range, General Electric JB480SMSS, Free-Standing Electric Radiant Smooth Cooktop, stainless
4. Undercounter Dish Washer, General Electric PDT145SSLSS, 18” ADA Compliant Dish Washer, stainless steel, with low-profile installation for 34” countertop height.
5. Washer (ADA Compliant, side-by-side installation): General Electric GFW430SSMWW, 4.5 cuft front load energy star washer, white.
6. Dryer (ADA Compliant, side-by-side installation): General Electric GFD43ESSMWW, 7.5 cuft front load Electric Dryer.

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 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: Comply with plumbing and electrical requirements.

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. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

C. An appliance will be considered defective if it does not pass tests and inspections.

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 residential appliances.

END OF SECTION

11 40 00

FOODSERVICE EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Documents, apply to the Work specified in this Section.

1.2 SUMMARY OF THE WORK

A. Location: Stafford HS Addition Renovation
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B. Approval of Working Surface: any contractor performing work over the work of other contractors shall notify the Architect of any unsatisfactory conditions. Beginning of work by any contractor shall constitute acceptance of the previous work.

C. Checking Dimensions at Site: before ordering any materials or doing any work, verify all measurements of the building and be responsible for the correctness of them. No extras will be allowed for variations from drawings in existing conditions or for work performed under this contract. Any discrepancies found shall be submitted to the Architect or Foodservice Consultant for instructions before proceeding.

D. Cutting and Patching: No excessive cutting will be permitted, nor shall any structural members be cut without the written approval of the Architect. Each Contractor shall leave all chases and openings straight, true and of the proper size in his work as may be necessary for the proper installation of his and other contractors' work. After such work has been installed, he shall carefully fit around, close up, repair, patch and point up same as directed, to the entire satisfaction of the Architect.

E. Cooperation: the General Contractor, all other contractors and all subcontractors shall coordinate their work with all adjacent work and shall cooperate with all other trades to facilitate the general progress of the work. Each trade shall afford all the other trades every reasonable opportunity for installation of their work and storage of their material.

F. Inspection and Tests: Architect, Owner, Foodservice Consultant and their representative shall at all times have access to the work whether it is in preparation or progress. Provide proper and safe facilities for such access and inspection.

G. Fees, Permits and Inspections: secure and pay fees for all permits, licenses and inspections as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

1.3 SCOPE

A. Include the Work specified, shown or reasonably inferable as part of Foodservice Equipment. Portions of this Work may be subcontracted to those qualified to do such work, as may be necessary because of jurisdictional trade agreements and restrictions.

B. The General Contractor is responsible for Related Work specified in other Sections: i.e. final plumbing, electrical and mechanical connections. The Foodservice Equipment Contractor is responsible for all internal connections when specified.

C. Specifications and drawings have been prepared to form the basis for procurement, erection, startup and adjustment of all equipment in this contract. Plans and specifications shall be considered as mutually explanatory and work required by one, but not by the other, shall be performed as though required by both. Items required by one, but not by the other shall be provided as though required by both. Work shall be accomplished as called for in specifications and shown on drawings, so that all items of equipment shall be completely functional for purpose for which they were designed. When there is any discrepancy between drawings and specifications, bidders should seek clarification of any discrepancies from the Architect/Consultant prior to bidding.

D. Should the drawings disagree in themselves, or the specifications with the drawings, the better quality, more stringent, and/or greater quantity of the work or materials shall be completed without additional costs to the Owner.

1.4 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Slab depressions, reinforced concrete wearing bed and interior finished floor with coved base at prefabricated cold storage assemblies: Divisions 03/09.

B. Concrete or masonry platforms with finished top and coved base at perimeter, for raised setting of foodservice equipment: Divisions 03/09.

C. Slab depressions to receive stainless steel drain trench liner/grate assemblies (provided under this Section): Division 03.

D. Dwarf-wall at exposed front/ends of cafeteria serving counters with finish as selected by Architect.

E. Corner guards: Division 09.

F. PVC or EMT Conduit with pull-wire and wide-sweep bends for refrigerant piping to remote foodservice equipment refrigeration systems: Division 22/26.

G. Empty EMT conduit with pull-wire and wide-sweep bends for interconnect cables between LAN and POS terminals, change-makers, pre-check units, printers, CPU's, etc.: Division 26.

H. Supply and exhaust fans for foodservice equipment and exhaust hoods: Division 23.

I. Roughing in and final connection of mechanical, electrical, and plumbing systems to foodservice equipment and cold storage assemblies by Divisions 22/23/26

J. Millwork /Casework Fixtures by Division 06.

1.5 QUALITY ASSURANCE

A. In addition to complying with applicable laws, statutes, building codes and regulations of public authorities, comply with the following:

1. National Sanitation Foundation (all equipment to bear label).
2. National Electric Code.
3. Underwriters' Laboratories, Inc. (all applicable equipment to bear label).

4. American Gas Association Laboratories.
5. National Fire Protection Association.
6. Americans with Disabilities Act.
7. Food and Drug Administration HAACP Guidelines.
8. International Conservation Code.
9. Environmental Protection Agency

B. Furnish certification of regularly manufactured equipment listing or classification by Underwriter's Laboratories, Inc. with initial submittal.

1.6 SUBSTITUTIONS

A. Equipment items or components specified are intended to be the Basis of Bid. All other brands, including any additional names, which may be listed as "Alternates" or "Approved Equal," must conform with the specifications, size, accessories, function, etc. of the first-named brand and be subject to Paragraph C-03 of this Article.

B. Proposed Substitutions:

1. Submitted no less than 14 calendar days prior to Bid Date.
2. Submit proposed substitutions with catalog data and/or manufacturer's shop details indicating all modifications required to conform with specified brand.
3. List of deviations must include listing of equipment name, model number, accessories and features with deviation(s) noted for both specified and proposed alternate equipment. Equipment without listed deviation(s) will be considered to be furnished as specified.

C. Substitutions with prior approval:

1. Submitted on Bidder's letterhead attached to Proposal Form with individual additive/deductive amounts stipulated and the documentation required in Paragraph B02.
2. Owner reserves the right to accept or reject any or all substitution proposals before execution of Contract.
3. Provide all design/engineering services required to make adjustments in space, systems, utilities, etc. and pay all additional costs of utilities, construction or professional services that may be incurred due to the acceptance of any substitution.

D. All appliances within common group or category (e.g., refrigerators, kettles, ovens, etc.): same manufacturer.

1.7 INTERPRETATION OF DOCUMENTS

A. During Bidding: contractor's, supplier's or vendor's questions and comments pertaining to Construction Document's clarity or intent will be addressed by addendum.

B. Subsequent to Award:

1. Confirmation of Construction Document requirements will be provided by Clarification Bulletin.
2. Request For Information Bulletins submitted by Contractor: contain Contractor's proposed resolution.

1.8 WARRANTY

A. Provide a written warranty for a period of one year from the date of Substantial Completion, including extended four-year replacement warranty on compressor bodies.

B. Components of equipment subject to replacement prior to one-year's use (such as refrigerator door gaskets) and those items which may fail due to improper or inadequate periodic maintenance by the Owner/Operator (such as an uncleaned refrigeration system condenser) are not intended to be included within the scope of the Warranty.

C. Refrigeration Systems/Equipment: one-year free service available within twenty-four hours of notification.

D. Furnish three copies of a list of all equipment and their respective local service agencies, indicating the address, telephone number and name of person to contact. Whenever possible, the service agencies selected shall be factory-authorized for the equipment assigned.

E. Provide following for refrigeration systems/equipment, unless specified otherwise:
1. One (1) year free service available within twenty-four hours of notification, for refrigeration systems.
2. Provide five (5) year manufacturer's registered written replacement, warranty certificate, covering compressor bodies. Warranty to cover labor costs for first year.
3. Provide ten (10) year manufacturer's registered written replacement/repair, warranty certificate, covering walk-in panels. Warranty to cover defects in material and workmanship. Warranty to cover labor costs for first year.
4. Provide one (1) year parts and labor warranty for all parts of refrigeration system(s) and walk-in cooler(s) and freezer(s), not otherwise covered herein.

F. All above stated warranty periods are from date of Substantial Completion.

1.9 SUBMITTAL DATA

A. Special Requirements: the following are in addition to any general requirements given elsewhere in the Documents.

B. Submittal Requirements:

1. Kitchen Equipment Contractor to furnish two (2) hard copies of all submittal drawings, two (2) hard copies of the brochures, Adobe PDF files on CD or via email of all submittals as indicated within the General Specifications.
2. Submittal data can be submitted electronically, in PDF format only, printed to scale, if acceptable by the Architect.
3. All shop drawings, rough in drawings, manufacturer drawings, and custom fabricated drawings to be included within one (1) complete submittal package.
4. Reviewed submittals are to be printed as required for each trade by the General Contractor and/or Kitchen Contractor.
5. Foodservice Design Professionals requires a minimum 10 business day review period after receipt of complete submittal package. Review period subject to size and scope of project.

C. Brochure Format (for regularly-manufactured equipment and components):

1. Front and rear protective cover with labeled project name.
2. Brochure index: indicate functional Area/Room number, item number, quantity, description and manufacturer.
3. A separate flysheet for each component or item of equipment, indicating: item number, name, quantity, manufacturer, optional equipment, modifications, special instructions and utility requirements. An item of equipment or assembly containing more than one

buyout sub-assembly or component shall have the secondary item listed in parenthesis beside the primary item name. For example: Serving Counter (hot food well).

4. Catalog specification sheet and manufacturer's drawing.

D. Shop Drawings (Rough-In Drawings):

1. Separate drawing sheets: same size as Contract Drawings (Contract Drawings are not to be traced or reproduced). Submittal drawings are to be provided by Kitchen Equipment Contractor and not reproduced from Contract Documents. Any reproduced submittal drawings will be rejected.
2. ¼" scale drawing of fixed/movable Foodservice Equipment and pre-fabricated Cold Storage Assemblies with itemized schedules.
3. Special Conditions Drawings, sizing and locating the following conditions:
   a. Slab depressions, cores, sleeves or block-outs (cold storage assemblies, drain trenches, piping, etc.).
   b. Concrete or masonry platforms.
   c. Pipe sleeves or roof jacks.
   d. Wall-openings or block-outs for pass-through equipment, recessed control panels, in-wall fire-protection system components, etc.
   e. Blocking grounds or anchor plates required in walls for equipment support/attachment.
   f. Above-ceiling hanger assemblies for support of exhaust hoods, utensil-racks, etc.
   g. Access panels in walls or ceiling for service of equipment.
   h. Ceiling pockets or recesses for unusually high equipment.
   i. In-wall carriers for wall-hung or cantilevered equipment.
4. Electrical rough-in drawing.
5. Plumbing/mechanical rough-in drawing.
6. Required information:
   a. All fixed and movable Foodservice Equipment shown on Contract Drawings.
   b. All prefabricated Cold Storage Assemblies and Conveyor/Dishtable Assemblies shown on Contract Drawings.
   c. All general-use and convenience utilities or services indicated on Contract Drawings, including those required by or connected to equipment or devices not in this Section.
   d. All rough-in drawings: fully dimensioned from engineering benchmark or finished-room surface to point of stub-up through floor and stub-out through wall or ceiling for all mechanical, electrical and plumbing services.
   e. Connection number/tag system and symbols: identical to Contract Drawings.

E. Shop Drawings (Manufacturer's and Fabricator's):

1. Sheet Size: identical to Contract Drawings, drawn or plotted at ¾" scale for plan view and elevations; 1½" scale for sections and construction details.
2. Included information: item number, name and quantity.
3. Construction details, sections and elevations to reflect requirements of the Specifications and Drawings.
4. Indicate adjacent walls, columns and equipment.
5. Indicate plumbing and electrical schematic drawings for equipment such as: conveyors, waste systems, self-cleaning exhaust hoods, exhaust hood fire protection systems and fabricated fixtures with single electrical or plumbing connection.
6. Mechanical or electrical operating components or products integrated into a fabricated fixture: ventilation and service access required or recommended by the manufacturer, including panel size and location to permit easy lubrication, adjustment or replacement of all moving parts.

F. All equipment and engineering rough-in plans sheet numbers are to match the contract documents. All equipment item no.'s and engineer item no.'s located on the schedules are to match the contract documents. All engineering requirements are to be updated as required to accommodate the provided equipment and/or match the contract documents. The Kitchen Contractor is responsible for the coordination of any MEP revisions to accommodate the provided and proposed equipment. The kitchen contractor is responsible for any cost associated to equipment substitution.

1.10 SERVICE MANUAL

A. Three copies bound in 1½" hardback, three-ring binders (as many volumes as required by scope of project) with same data as brochure at completion of installation (Refer to "Submittal Data"). Provide separate service manuals as required for each independent area within the project scope (Main Kitchen, Culinary, Concession, etc.).

B. Each Volume: section for maintenance of finish materials (e.g., stainless steel, plastic laminates, FRP, Plexiglas, etc.).

C. Catalog specification sheet and/or manufacturer's shop drawings.

D. Each Volume: index of items, manufacturer's operating/maintenance information, replacement parts data and price lists. Provide the name, title and address of personnel at each respective manufacturer to be contacted for spare/replacement parts after warranty period.

E. To the extent possible, provide two copies of manufacturer's video instructional cassettes for operating, maintenance and service of equipment.

F. Internally subdivide binder contents with permanent page dividers, logically organized by equipment item number or manufacturer name, with tab titling clearly printed under reinforced laminated plastic tabs.

G. Electronically submitted manuals are required to follow the same formatting requirements listed above.

1.11 VERIFICATION AND COORDINATION OF PROJECT / DATA

A. Utilities Rough-in Drawings and Field-Services within four weeks after receipt of notice-to-proceed, review Contract Drawings and Submittal Data for accuracy and completeness and notify Architect of conflicts and proposed adjustments. Coordinate work with other sub-contractors.

1. Provide on-site field verification of all underground utilities prior to pouring of concrete for capacity and location, coordinate with General Contractor. Submit review to Architect and General Contractor.
2. Provide on-site field verification of all other utility connections and locations, coordinate with General Contractor. Submit review to Architect and General Contractor.

B. Review critical systems/components for application, performance and capacity and submit calculation worksheets with initial submission of brochure/rough-in drawings, with all proposed adjustments noted, including:

1. Exhaust hood removal/supply air volume, velocity, static pressure, duct collar sizes and locations.

2. Refrigeration Systems (compressor, condenser and evaporator) capacities/sizes, quantities and refrigerant piping distances/sizes.
3. Exhaust Hood Fire Suppression Systems (nozzle locations, air handler and fuel interlocks, piping/distance limitations).
4. Locations of Vacuum Breakers.
5. Conformance of Refrigerated Components/Equipment with HACCP Guidelines (e.g., salad/sandwich pans, upright/open refrigerator cabinets, salad bars) with HACCP Guidelines.
6. Gas, water line sizes and manifold configurations.
7. Diameter and length of flexible connector lines for fixed/movable gas appliances.
8. Fabricated Equipment load center panels (individual and total amperage calculations and circuit balance).
9. ADA compliance of workstations, service positions, passageways, etc.

C. Ceiling mounted appliances/fixtures: verify and coordinate dimensions/location of support framing/hangers with General Contractor. All material and installation below 12'-0" aff.: Section 11 4000.

D. Dimension Responsibility: obtain actual or guaranteed measurements for proper fit of equipment. All dimensions indicated in Contract Documents are approximate and are as accurate as can be determined at the time. Field-check all horizontal/vertical measurements and conditions at the building prior to fabrication or delivery of equipment and notify the Architect of all conflicts or deviation from the dimensions shown.

E. Checking Dimensions at Site: before ordering any materials or doing any work, verify all measurements of the building and be responsible for the correctness of them. No extras will be allowed for variations from drawings in existing conditions or for work performed under this contract. Any discrepancies found shall be submitted to the Architect for instructions before proceeding.

F. Scheduling to Fit Openings: should it become necessary to schedule construction of walls or partitions prior to delivery of fixed equipment, the equipment must be fabricated for passage through finished openings. Maintain close contact with the project and be cognizant of all conditions, including vertical handling limitations within the building (elevator cabs or openings, stairs, etc.) and possible hoisting requirements. Coordinate all procedures with General Contractor and Project Team.

G. Refrigerated and Dry Storage Areas: verify and coordinate dimensions to accommodate scheduled modular shelf sections. Notify Architect of variance between the Contract Documents and actual conditions.

H. Color/Pattern Selections: submit selection samples of solid polymer products, plastic laminate, paint or stain finishes and vinyl-coated surface material of equipment as selected by Owner.

I. Movable Equipment Interface: rolling stock (pan racks, carts, dollies, dish/tray/rack dispensers) required to fit through or into fixed equipment (roll-in refrigerators, counter bodies, etc.) is to be reviewed and coordinated for compatibility at time initial of shop drawing submittal. Indicate conflicts and proposed adjustments.

J. Relocation of Work: relocate or re-route work as required to coordinate related items free of charge if no extra work is involved.

1.12 EQUIPMENT FURNISHED / INSTALLED BY OTHERS

A. Obtain and coordinate utility requirements of Owner-Furnished/Owner-Installed (OF/OI) equipment with the building utilities and roughing-in drawings/provisions.

B. Coordinate physical data of OF/OI appliances or equipment and incorporate information into Submittal Drawings. Vendor- or Purveyor-Furnished equipment (e.g., coffee/tea equipment): same as OF/OI.

1.13 WORK INSTALLED BUT FURNISHED BY OTHERS

A. Coordinate delivery/installation schedule of Owner-Furnished/Contractor-Installed (OF/CI) equipment with Owner not less than ninety (90) days before equipment requirement.

B. Obtain and coordinate utility requirements of OF/CI equipment with the building utilities and roughing-in drawings/provisions.

C. Receive at job-site and fully incorporate into installation procedures as if furnished under this Section.

PART 2 - PRODUCTS

2.1 FABRICATED FIXTURES MATERIAL / COMPONENTS

A. Stainless steel sheets or shapes: 18-8, Type 302, polished to 180 grit No. 4 finish.

1. Stainless steel joints and seams: heli-arc welded, free of pits and flaws, ground smooth and polished to No. 4 finish.
2. The “grain” direction of horizontal stainless-steel surfaces: longitudinal, including the splashback. The polishing procedure at right-angle corners of fixtures shall provide a mitered appearance.

B. Galvanized Iron Sheets: Armco copper bearing Zinc Grip or Zinc Grip/Paint Grip.

1. Galvanized iron joints and seams: arc-welded, free of pits and flaws and ground smooth.
2. Galvanized sheets or shapes: washed with mineral spirits and painted with Rustoleum gray semi-gloss enamel.

C. Sound Deadening: Schnee Butyl Sealant ½” wide rope positioned continuously between all frame-members or contact material and underside of stainless steel surface (sinks, table tops, food wells, overshelves and undershelves). Tighten stud-bolts for maximum compression of sealant and trim excess.

D. Plastic Laminates: color/pattern selected by Architect, in 1/16” thickness for flat surfaces: 1/32” thickness for radiused surfaces. Plastic laminates and adhesives must be N.S.F. approved (Standard No. 35).

E. Solid Polymer products: color/pattern/material as selected by Architect in thickness as specified. Solid Polymer and adhesives must be N.S.F. approved (Standard No. 51).

F. Casters.

1. Fabricated fixtures with “Open Base” construction: Jarvis and Jarvis Model No. 5-405-113P-NSF swivel casters with grease seals on forks and wheels; Zerk fitting in swivel; two casters: Model No. E-75 Vertilock brakes. All casters: B-7” rolling bumpers with stainless steel top discs.

G. Cutting Boards: 1/2" thick Read Products, Inc. "PolyLite" cutting board, size as indicated.

H. Identification Plates, Labels, Tags:

1. Prohibited Information: names of suppliers, fabricators and contractors.
2. NSF Labels: required on all pieces of equipment.
3. Required Information: function or purpose of controls such as display light switches, food warmer controls, etc.
4. Plate Construction: engraved phenolic plastic, secured to equipment with epoxy cement or stainless-steel screws. Furnish samples.

2.2 PLUMBING / MECHANICAL REQUIREMENTS

A. Plumbing Fittings and Components: furnished under this Section as follows:

Note: Fitting and components described in Items 1, 2, 3,4 and 5 are furnished loose for installation by Division 22.

1. Control valves, appliance pressure regulators for water, gas and steam, and vacuum breakers: wherever required on Foodservice Equipment (chrome-plated where exposed).
2. Faucets and drains without connected overflows (unless otherwise indicated) for all sinks.
3. Specialty Foodservice water-fill faucets or hose assemblies indicated in drawings/specifications.
4. Wade Model No. W-10 Shock-Stop shock absorbers for all Foodservice Equipment with quick-opening or solenoid-operated water valves.
5. Dormont Stainless Steel Water Quick Disconnect hose, diameter per water connection size requirements, with SafetyQuick safety fitting, w/coiled restraining device, full port gas valve, antimicrobial coating, lifetime warranty.
6. Extensions of indirect waste fittings to open-sight floor sink or floor drains from sinks, under bar equipment, and food-holding components of serving counters (e.g. cold pans, hot food wells, refrigerator/freezer coils not equipped with condensate evaporators) furnished and installed by Division 22. Drains: painted with aluminum paint where exposed, type "K" copper where concealed.
7. Piping brackets and supports beneath/within fabricated equipment.
8. Closed Base Bodies: removable 18-gauge stainless steel closure panel at plumbing penetrations, under top.
9. Control valves on Open Base fixtures: mounted on 14-gauge stainless steel gusset-shaped panel with 3½" setback from counter top edge/rim to face of control handle.
10. Fill hose/faucet at support pedestals or Closed Base Body: installed in a 15" x 18" x 5" deep recessed mounting panel. Panel bottom: sloped on a 60o angle, with 3/8" stainless steel rod hanger-bracket for hose.
11. In-line water filter system:
    a. Everpure System filters for coffee/tea brewers, icemakers, water chillers, convection steamers and beverage systems.

B. Gas-Heated Equipment Fittings and Components: furnished under this Section as follows:

1. Fixed Equipment: Dormont MFG brand "KITCF" Series gas hose kit with Quick Disconnect fitting at appliance. Approved equal: T&S Brass. Diameter per fuel volume/connection size requirements. Gas valve diameter size per fuel volume/connection size requirements.

a. Restraining device: heavy duty steel cable, fastened to equipment and walls, 3" to 6" shorter than equipment connector length.

C. Final Plumbing Connections Provisions.

1. Fabricated equipment containing components, fittings and/or devices indicated on Foodservice Connection Drawings to be connected to the building systems: each component, fitting or group thereof pre-piped to a utility compartment for final connection by Division 22. Refer to drawings for capacities.
2. Field-assembled equipment (e.g., prefabricated walk-in refrigerator/freezers, exhaust hoods, warewash machines, convection ovens, etc.): plumbing components completely interconnected under this Section for final connection arrangements indicated on Utility Connection Drawings.
3. All plumbing final connection points of equipment shall be tagged, indicating:
   a. Item number.
   b. Name of devices or components.
   c. Type of utility (water, gas, steam, drain, chilled water).

D. Ducts and Vents.

1. Exhaust hoods which are furred-in to ceiling: 2" high duct collar for final connection to duct system.
2. Warewash machines equipped with integral vent cowls or extended hoods: furnished with 18-gauge stainless steel seamless duct risers to 6" above finish ceiling for final connection. The duct: trimmed at ceiling with 16-gauge stainless steel angle flange with all corners welded.

2.3 FOODSERVICE EQUIPMENT REFRIGERATION SYSTEMS

A. Install complete with all refrigerant, oil, dials, dehydrators, gauges, controls required for the proper operation of the system.

B. Self-contained or factory-installed compressors: check and adjust to proper operating temperature prescribed by FDA/HACCP.

2.4 PLUMBING TRIM

A. Faucets: furnished for all sinks or equipment requiring open water supply.

B. Fill Faucets: furnished for appliances requiring open water supply.

C. Drain Fittings: furnished for all sinks or equipment requiring removal of liquids. Install specified chrome-plated or stainless-steel fittings in die-stamped openings with washers and locknuts. Solder may be used as a sealer but shall not be applied to the top surface of the drain fittings.

2.5 ELECTRICAL REQUIREMENTS

A. All electrical systems, components and accessories within the work of this Section: certified to be in accordance with NEC 70.

B. Electrical Fittings and Components: furnished under this Section as follows. Coordinate foodservice equipment loads, voltage and phase with building system and confirm any existing or OF/OI equipment requirements.

C. Cord and Caps.

1. Coordinate all Foodservice Equipment cord/caps with related receptacles.
2. All 120 volt “plug-in” equipment shall have Type SO or SJO cord and plug with ground wire fastened to frame/body of item.
3. Cord lengths for fixed equipment: adjusted to eliminate loose-hanging excess.
4. All non-fixed plug-in “buy-out” equipment: Hubbell configuration, ratings as required.
5. All mobile electrical support equipment (heated cabinets, dish carts, etc.) and counter appliances mounted on mobile stands (mixers, food cutters, toasters, coffee makers, microwave ovens, etc.): 8’-0” cord length with cord-hanger strap secured to rear of equipment or mobile stand.

D. Switches and Controls.

1. Each motor-driven appliance or electrically heated unit: equipped with control switch or starter per Underwriters’ Laboratories, Inc. with low-voltage and overload protection.
2. Disposer controls recess-mounted in wall: external fittings and accessories removed from enclosure and furnished with 16-gauge stainless steel perimeter angle flange with welded corners. Install control at 4’-0” aff to bottom of enclosure.
3. Disposer controls recess-mounted in counter-splash risers: external fittings and accessories removed from NEMA 4 enclosure and furnished with 16-gauge stainless steel perimeter angle flange with welded corners. Install control at 3’-0” aff to bottom of enclosure. Provide panel with 60” long coil of Seal-Tite electrical conduit, from bottom of control panel for final field connections under Division 26.
4. Equipment which is not provided with built-in circuit breakers or fused terminal block and is indicated on Utility Connections Drawings to be directly-connected to the building electrical system: a NEMA 4 stainless steel disconnect switch furnished and installed by Division 26.
5. All remote manual starters, disconnect switches, magnetic contactors or starters and push-button stations: NEMA Type 4 enclosure; NEMA Type 1 enclosure only when installed in a Closed Base Body.

E. Heating Elements.

1. Electrically-heated equipment: thermostatic controls.
2. Water heating equipment: equipped with positive low water shut-off.

F. Receptacles and Switches.

1. Receptacles installed in vertical panels of support pedestals or Closed Base Bodies: installed in 12” x 8½” x 3” deep recessed mounting panel sloped on 60o angle and turned up to top of opening.
2. Pre-wire receptacles in closed base fixtures to a junction box installed within 6” from bottom of utility or compressor compartments.
3. Receptacles mounted on Open Base fixtures: installed on 12” x 10½” x 4½” deep 14-gauge stainless steel panel with returned ends and sloping recess. Secure panel to underframe of fixture top.
4. Pre-wire receptacles on open base fixtures to a junction box secured to a leg or mounted on underside of lower shelf. Vertical runs of wiring: made in rigid conduit or within the tubular leg.
5. Receptacles installed in/on-fabricated equipment: Hubbell, Inc. assemblies horizontally-mounted in a metal box with stainless steel cover plate.
6. Switches installed in/on-fabricated equipment: Hubbell, Inc. with metal box and stainless-steel cover plate. Switches: pre-wired to the controlled device and to a

junction box installed within 6" from bottom of utility or compressor compartment. All refrigeration system switches: installed within the compressor compartment near the door opening.

7. Load centers installed in/on fabricated equipment to have all fixture components pre-wired to load center with balanced phase loading. Load center: ready for final connection by Division 26 and flush-mounted within utility compartment rear panel, set back 8" from access door. All breaker/device information: typewritten on circuit schedule in load center door (number corresponding breaker/device) with enclosed schematic wiring diagram of fixture components.

8. All receptacles to be pre-wired to cord and plug assembly and routed through overshelf post at all island equipment locations, unless specified otherwise.

G. Light Fixtures.

1. Light fixtures with lamps installed in/on fabricated or field-assembled equipment: pre-wired to a junction box for final connection (continuous-run fixtures when indicated).
2. LED Display Light: install light fixtures full-length of Display Stand and Serving Shelf with stud bolts and pre-wire through support posts to an apron-mounted switch.
3. Heat Lamps: installed to underside of serving shelf assemblies. When multiple 24" heat lamps are specified, provide maximum length heat lamp chassis. Install all switches remote from lamps.
4. Cold Storage Light Fixtures: Furnished by Section 11 40 00 and installed by Div. 26. All electrical wiring and conduit provided by Div. 26. electrically connected through the hub fitting located on the top of the fixture. All horizontal conduit: above ceiling panels. Install plastic sleeve through ceiling panels for electrical conduit. Seal sleeved penetrations airtight at both sides of panel. All penetrations to be sealed by Kitchen Equipment Contractor.

H. Final Electrical Connection Provisions.

1. Fabricated equipment containing electrically-operated components or fittings indicated on Utility Connections Drawings: direct-connected, with each component, fitting or group pre-wired to a junction box for final connection by Division 26. Refer to drawings for circuit loading.
2. Fabricated equipment containing electrically-operated components and/or devices indicated: circuit-breaker load center with each component or device pre-wired to a separate circuit breaker for balanced phase loading and single final connection by Division 26.
3. Field-assembled equipment (e.g., prefabricated cold storage assemblies, exhaust hoods, warewash machines, etc.) shall have electrical components completely interconnected in this Section for final connection arrangements as indicated on Utility Connection Drawings by Division 26.
4. Pre-wire the following groups of cold storage assembly electrical devices to a top-mounted junction box for final connection by Division 26 per compartment grouping (unless otherwise indicated).
   a. Light fixtures and switches; heated pressure-relief vent.
   b. Door/jamb heaters.
   c. Evaporator fans, defrost elements and drain line heaters.
5. All electrical final connection points of equipment shall be tagged, indicating:
   a. Item number.
   b. Name of devices on circuit.
   c. Total electrical load.
   d. Voltage and phase.

I. Lamps: in all Foodservice Equipment containing light fixtures. Refrigerator or heated cabinets: All exposed LED lamps above or within a food zone: Shat-R-Shield lamps or standard lamps, sleeved with end caps.

2.6 CUSTOM - FABRICATED / ASSEMBLED UNITS

A. Mechanical or electrical operating components or products integrated into a fabricated fixture: ventilation and service access required or recommended by the manufacturer. The service access panel(s) size and placement is to permit easy lubrication, adjustment or replacement of all moving parts and is to be indicated on fabrication shop drawings.

2.7 PRE-APPROVED KITCHEN SUPPLIERS

A. Only the following named Subcontractors and those approved later, if any, are approved for inclusion in the Contractor's Bid.

B. Any supplier requesting for inclusion within this bid will be required to submit AIA form 305 minimum 14 days prior to bid date for review, or as required by Architect.

1. Ed Don & Company, 3501 Plano Parkway, The Colony, Texas 75056, Mr. Scott Jost, Phone: (972) 624-7460, Fax: (972) 624-7762, E-mail: scottjost@don.com
2. Kirby Restaurant Supply, Mr. Billy Anderson, 809 S. Eastman Road, Longview, Texas 75602, Phone: (903) 757-2723, Fax: (903) 757-9519, Email: billya@kirbyrestaurantsup.com
3. Pasco Brokerage, Inc., Mr. Bill Hollon, 2929 Custer Road, Suite 301, Plano, Texas 75075, Phone: (972) 5963350, Fax: (972) 5962817, E-mail: bhollon@pascoinc.net
4. Mission Restaurant Supply, '6509 North Lamar Blvd, Austin, Texas 75752. Mr. Bruce Walker, Phone (512) 389-1705, Fax (512) 389-1746, E-mail: brucew@missionrs.com.
5. Custom Kitchen Equipment Company, 2601 Wilson Road, Humble, Texas 77396, 281-446-8187, Fax: 281-446-8180.
6. Texas Metal Equipment Company, Mr. Andrew Harman, 6707 Mayard, Houston, Texas 77041, 713-466-8722, Fax: 713-466-0166.
7. Kommercial Kitchens, Mr. Terry Woodard, 13544 East Fwy., Houston, TX 77015, 832-767-5287
8. Stafford Smith, Mr. JP Garcia, 23203 FM 2100 Rd., Huffman, TX 77336, 281-324-4203

PART 3 - EXECUTION

3.1 DELIVERY AND INSTALLATION

A. Supervision: provide a competent foreman or supervisor who shall remain on the job during the entire installation.

B. Delivery: coordinate with progress of construction and Owner's operation schedules. Unless otherwise instructed and documented by Owner or General Contractor, the following procedures apply:

1. Field-Assembled Fixed Equipment integrated into the structure (e.g., cold storage assemblies, exhaust hoods, drain trench/grate assemblies, conveyor systems, ceiling-mounted utensil racks, etc.) are to be sent to the job-site when directed by the General Contractor and installed/protected accordingly.

2. All other Fixed Equipment: delivered after completion of work on adjacent finished ceilings, lighting, finished floor and wall systems, including painting.
3. Major Movable Equipment: delivered when possible to inventory in secured area for interim job-site storage or, if secured area is not available, when fixed equipment installation/clean-up has been completed.
4. Minor appliances and loose items (e.g., pans, covers, flatware containers, etc.) delivered only when Owner is prepared to receive and inventory such items.

C. Installation: performed by manufacturer of custom fabricated fixtures.

1. Assemble, square, level and make ready all items for the final utilities connections.
2. Cut neatly around obstructions to provide sanitary conditions.
3. Where gaps of ¼" or less occur adjacent to or between equipment, insert rope backing and smoothly-applied General Electric construction sealant Series SE-1200 silicone mastic (white color). Mask both sides of gap for neat application of sealant and remove excess. If space exceeds ¼", neatly install 18-gauge stainless steel trim molding of proper shape with concealed attachment. Use epoxy cement or "Z" clips wherever possible to secure stainless steel trim. Exposed edges or corners of trim: eased and smooth.
4. Refrigeration coil drain line runs to indirect drain connection greater than 2" from face of wall or panel: either of the following field procedures.
   a. Trench the floor and provide 6" wide x 2" deep 16-gauge stainless steel sloping (-1" to -2") trough from face of cooler/freezer wall to body of floor sink/floor drain. Trough: turned up 4" at wall; ¾" flange with ½" turndown at both long sides. Set trough in waterproof mastic and seal 1" o.d. drain tube penetration into floor sink/floor drain at -2½" bff. Patch the floor to match adjacent material/surface.
   b. Provide 12" x 6" x 2" deep 16-gauge stainless steel condensate pan mounted to cooler/freezer wall at 6" aff clear. Trench the floor and install 1" o.d. drain line from bottom of pan to body of floor sink/drain. Slope drain line ¼" per foot and seal all connections watertight. Patch the floor to match adjacent material/surface.

D. Protection of Work:

1. Fabricated fixtures: fiberboard or plywood taped to tops and exposed body panels/components.
2. Manufactured Equipment: fiberboard or plywood taped as required by equipment shape and installation-access requirements.
3. Prohibited use of equipment: tool and materials storage, workbench, scaffold, stacking area, etc.
4. Damaged Equipment: immediately documented and submitted to Owner with Contractor's recommendation of action for repair or replacement and its impact on the Project Schedule and Contract Amount, if any.

3.2 CLEAN AND ADJUST

A. Clean up and remove from the job site, all debris resulting from this Work as the installation progresses.

B. Thoroughly clean and polish interior/exterior of all Foodservice Equipment, prior to demonstration and final observation, ready for Owner's use.

C. Lubricate and adjust drawer slides, hinges, casters.

D. Adjust pressure regulating valves, timed-delay relays, thermostatic controls, temperature sensors, exhaust hood grilles, etc.

E. Clean or replace faucet aerators, line strainers.

F. Touch-up damage to painted finishes.

G. Start up and check operation of all refrigeration systems for at least 72 hours prior to acceptance.

3.3 EQUIPMENT START-UP/DEMONSTRATION

A. Carefully test, adjust and regulate all equipment in accordance with the manufacturer's instructions and certify in writing to the Owner that the installation, adjustments and performance are in full compliance.

B. Provide the Owner or Foodservice Operators with a thorough operational demonstration of all equipment and furnish instructions for general and specific care and maintenance. Coordinate and schedule selected items of equipment and attendees with Owner at least two weeks in advance of demonstration periods.

3.4 FINAL OBSERVATION

A. Final observation will be made when the Contractor will certify that he has completed his work, made a thorough review of the installation/operation of each item in the contract and found it to be in compliance with the Construction Documents.

B. Repetitive final observations (more than two) and all costs associated thereto which may be incurred due to the Contractor's failure to comply with the requirements of this Article will be invoiced to this Contractor on a $70.00/hr. and expense basis.

PART 4 - EQUIPMENT SCHEDULE

4.1 REGULARLY-MANUFACTURED EQUIPMENT/COMPONENTS: standard finishes and accessories unless specifically deleted or superseded by the Contract Documents.

4.2 FABRICATED AND FIELD-ASSEMBLED EQUIPMENT: Arrangement and configuration as shown on Plans, Elevations and Detail Drawings.

4.3 REFER TO DRAWINGS for unit quantities and electrical or mechanical provisions required, including manufacturer's optional voltages, wattages, burner capacities, etc.

4.4 REFER TO PART 2 - PRODUCTS for accessories, fittings, requirements and procedures related to the listed buy-out and fabricated equipment.

4.5 ALTERNATE MANUFACTURER REQUIREMENTS: A specific product manufactured by the following listed pre-approved equals are acceptable only if the specific product can evidence compliance with the specified item and the contract documents:

4.6 RE-USED EXISTING EQUIPMENT

A. Existing equipment scheduled for re-use is to be inventoried and documented that equipment is in operating condition once Kitchen Contractor has taken ownership.

B. Provide pictures of all equipment once inventoried and issued to the architect to ensure that equipment has not been damaged.

C. Verify locations of all equipment with owner.

D. Existing equipment that is to be reused may be missing parts or accessories for proper and complete operation. Submit report listing all items with pricing for approval to allow complete installation.

E. Utility disconnection and re-connection: under Divisions 22 and 26. Kitchen Contractor to verify utility requirements of existing equipment and coordinate with Kitchen Consultant as required. All utilities not scheduled for re-use to be capped and covered by required disciplines.

F. Disassembly, removal, transportation and relocation: under this Section and scheduled with General Contractor. Owner's representative must be present, coordinate date / time with owner.

G. Thoroughly clean inside and out prior to relocation.

H. Review functional parts (e.g., doors, controls, heating elements, compressors, etc.) and submit report of required repairs and estimate of cost. Any finishes or equipment damaged due to construction to be repaired as required.

I. Existing equipment not scheduled for reuse is to be carefully removed/relocated by the Kitchen Contractor per the Owner's direction. Kitchen Contractor to coordinate date / time with General Contractor and Owner.

J. Removal or replacement of existing equipment is to be scheduled for times of least interruption and inconvenience to the foodservice operation. Submit proposed schedule of time frame, task sequence and operation for approval prior to starting work.

K. Kitchen Contractor to verify size and shape for all existing equipment being re-used and coordinate with Foodservice Consultant as required.

L. Any modification(s) required/desired for re-used existing equipment to be verified by the Kitchen Contractor. All modifications must be approved by the Owner and Foodservice Consultant prior to the modifications being made.

M. The KEC is to verify and coordinate all of the utility requirements with the construction documents as required. Refer to the general specifications re: conflicts.

4.7 FOODSERVICE EQUIPMENT

A. All equipment to have a performance check from factory authorized personnel. Warranties will begin on the day of performance check.

ITEM NO. 104 STORAGE SHELVING QUANTITY 2

Manufacturer: Metro
Model: Metro Max Q
Size and Shape: Refer to drawings

1. Each unit to be Four (4) tiers high with open grid shelving.
2. Four (4) 74" posts per unit.
3. Refer to drawings for size, width and lengths.

4. Casters w/ brakes.
5. Special Instruction: Verify shelving requirements with approved submittal prior to ordering.

ITEM NO. 107 DRY STORAGE SHELVING QUANTITY 2

Manufacturer: Metro
Model: MetroMax Q
Size and Shape: Refer to drawings

1. Each unit to be Five (5) tiers high with open grid shelving.
2. Four (4) 74" posts per unit.
3. Refer to drawings for size, width and lengths.
4. Security cage accessory.
5. Caster w/ brakes
6. Special Instruction: Verify shelving requirements with approved submittal prior to ordering.

ITEM NO. 122 TWO COMPARTMENT SINK

QUANTITY 1

Manufacturer: Advanced Tabco
Model: 923636RL
Size and Shape: Refer to drawings

1. Regaline Sink, 2 compartment with 36" left and right drainboards.
2. Provide One (1) T&S model no. B-0133-01-44H pre-rinse, two (2) B-0109-04 18" wall bracket (dealer cut to correct length), one (1) additional spray face model no. 108SFRK with ceramic cartridges. One (1) Add-A-Faucet attachment.
3. Two (2) Fisher 22306 twist waste valve 3 1/2" x 2" with overflow and tailpiece. Provide 18 gauge S/S bracket for drain handle welded to sink bottom.
4. 12" deep single post mounted perferated overshelf at 18" above counter top, punched to accommodate spray rinse.
5. Post mounted utensil rack, extend 1-5/8" diameter S/S post from back splash, turn forward 12" and weld full length x 2" x ¼" S/S bar with Component Hardware model no. V-77-4401 S/S sliding hooks at 8" on center. Verify height with owner.
6. Two (2) "Richlite" ½" thick removable sink covers installed at each sink. Weld ¼" bar stock, set 5/8" below work surface at all four corners for support of sink covers. Two (2) finger holes per board.
7. Provide top and bottom c-channel support storage for sink covers at right or left end of counter.
8. Flanged feet at front only.
9. Seal at all splash penetrations.

ITEM NO. 130 WORKTABLE QUANTITY 3

Manufacturer: Advance Tabco
Model: KSLAG-302-X
Size and Shape: Refer to drawings

1. S/S undershelf.
2. Open base construction. Bullet feet.

ITEM NO. 137 SPEED RACK QUANTITY 3

Manufacturer: Channel
Model: 53C
Size and Shape: Refer to drawings

1. Heavy duty casters, Two (2) with brakes.
2. Corner bumpers.

ITEM NO. 139 MOBILE PROOFER QUANTITY 1

Manufacturer: Winholt
Model: INHPL-1836C-DGT
Size and Shape: Refer to drawings

1. Four (4) casters, two (2) with brakes.
2. Lift off clear door.
3. Removable control drawer.
4. Digital control.
5. Cord and plug. Coordinate NEMA configuration with Electrician.
6. 1500 watt heater.
7. Insulated proofer/heated cabinet.

ITEM NO. 151 FIRE PROTECTION SYSTEM QUANTITY 1

Manufacturer: By MECHANICAL CONTRACTOR
Model: ---
Size and Shape: Refer to drawings

1. Refer to Mechanical Contractor's documents.

ITEM NO. 152 EXHAUST HOOD QUANTITY 1

Manufacturer: By Mechanical Contractor
Model: ---
Size and Shape: Refer to drawings

1. Refer to Mechanical Contractor's documents.

ITEM NO. 161 CONVECTION OVEN QUANTITY 1

Manufacturer: Vulcan
Model: VC66GD
Size and Shape: Refer to drawings

1. S/S front, top and sides.
2. Two (2) 1/2 HP 2-speed motors.
3. Natural gas.
4. Solid state infinite control with manual timer.
5. Electronic spark ignition.
6. Five (5) oven racks per compartment.
7. Dual pane thermal windows.
8. Simultaneous door operation.
9. S/S adjustable legs.

10. Provide quantities and sizes required: Dormont Model #VER-KITCF-2S-48" Gas Conn. Kit, 48" long, dble. Supr-Swivel coupling with SafetyQuick safety fitting, w/coiled restraining device, full port gas valve, antimicrobial coating, lifetime warranty.
11. Dedicated gas connections, do not manifold.
12. Special Instruction: Shunt trip breaker by Division 26.

ITEM NO. 167 MOBILE WORKTABLE QUANTITY 8

Manufacturer: TABCO
Model: SLAG-305-X
Size and Shape: Refer to drawings

1. Open base construction.
2. 16 gauge S/S undershelf per drawings.
3. 5" N.S.F. approved non-marking swivel casters, two with brakes.

ITEM NO. 192 REACH-IN REFRIGERATOR QUANTITY 1

Manufacturer: Traulsen
Model: G-32000
Size and Shape: Refer to drawings

1. Anodized aluminum interior and exterior.
2. Interior lights with bulbs.
3. Exterior digital thermometer.
4. Locking hardware.
5. 6" high adjustable S/S legs.
6. Furnish start-up and three (3) years repair service, including parts and labor.
7. Five (5) Year compressor warranty.
8. Cord and plug assembly.
9. Six (6) additional shelves

ITEM NO. 195 REACH-IN FREEZER QUANTITY 1

Manufacturer: Traulsen
Model: G31000
Size and Shape: Refer to drawings

1. Anodized aluminum interior and exterior.
2. Interior lights with bulbs.
3. Exterior digital thermometer.
4. Locking hardware.
5. Six (6) additional shelves.
6. 6" high adjustable S/S legs.
7. Furnish start-up and three (3) years repair service, including parts and labor.
8. Cord and plug assembly.
9. Five (5) Year compressor warranty.

ITEM NO. 262 HAND SINK QUANTITY 3

Manufacturer: Advance Tabco
Model: 7-PS-18

Size and Shape: Refer to drawings
Alternate:

1. Hand Sink, wall model, 14" wide x 10" front-to-back x 5" deep bowl.
2. 3 1/2" gooseneck splash mount faucet with wrist blade operation.
3. Basket drain and wall bracket.
4. P-Trap assembly, delete open/close drain valve.
5. Soap and Towel Dispensers by Owner.
6. 12" high custom fabricated removable end splashes on sides as required by code.
7. Provide Zurn Model: ZW3870T-49 mixing valve.
8. Water Temperature guard with 025 GPM Min. flow and ASSE 1070: Leonard 170-LF
9. Special Instructions Division 22 to provide temperature adjustment valves as required

ITEM NO. 616 DOUBLE DECK OVEN QUANTITY 1

Manufacturer: Radiance
Model: RBDO-43
Size and Shape: Refer to drawings

1. Three (3) tiers, Four (4) pans per tier.
2. Top and bottom heating elements per deck.
3. Oven deck brush, steel wirebristles, wood handle, 48" long.

ITEM NO. 632 SIX BURNER RANGE QUANTITY 1

Manufacturer: Vulcan
Model: 36S-6B
Size and Shape: Refer to drawings

1. Standard oven with two (2) oven racks.
2. Stainless steel front, sides,
3. 3/4" rear gas connection.
4. 10" high stainless steel backguard.
5. Heavy duty casters, two (2) with breaks.
6. Provide quantities and sizes required: Dormont Model #VER-KITCF-2S-48" Gas Conn. Kit, 48" long, dble. Supr-Swivel coupling with SafetyQuick safety fitting, w/coiled restraining device, full port gas valve, antimicrobial coating, lifetime warranty.

ITEM NO. 644 ELECTRIC CORD REEL QUANTITY 4

Manufacturer: By Electrical Contractor
Model: Safelite 4040-4201
Size and Shape: Refer to drawings

1. Provided by Trade Contractor.

ITEM NO. 704 FRYER BATTERY QUANTITY 1

Manufacturer: Existing
Model: ---
Size and Shape: Refer to drawings

1. Refer to Section 4.06 Re-Used Existing Equipment.

ITEM NO. 801 DEMO TABLE QUANTITY 1

Manufacturer: Advance Tabco
Model: VSS-DT-365
Size and Shape: Refer to drawings

1. Heavy duty casters, Two (2) with brakes.

END OF SECTION 11 40 00

12 21 00

HORIZONTAL LOUVER BLINDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes furnishing and installing window shades at exterior window vision lights indicated.
   1. Section includes furnishing and installing manual, horizontal louver blinds with aluminum slats at all exterior window vision lights within glazing system enframement, surface mounted on head, and extending to sill.
   2. Work excludes vision lights at all exterior doors and sidelights.

1.3 RELATED WORK

A. Related Work of Other Sections:
   1. Section 08 41 00 – Entrances and Storefront

1.4 SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, details of installation, operational clearances, wiring diagrams, and relationship to adjoining Work.
   1. Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
   2. Provide coordination drawings drawn to scale and coordinating penetrations and ceiling-mounted items.

C. Samples: For each exposed finish and for each color required.

D. Window Treatment Schedule: Use same room designations indicated on Drawings.

E. Maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products A qualified installer, approved by manufacturer to install manufacturer's products.

B. Horizontal Louver Blinds Fire-Test-Response Characteristics: Provide products passing flameresistance testing according to NFPA 701 by a testing agency acceptable to authorities having jurisdiction.

C. Corded Window Covering Product Standard: Comply with WCMA A 100.1.

PART 2 PRODUCTS

2.1 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS

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. Hunter Douglas Contract.
   2. Levolor Contract; a Newell Rubbermaid company.
   3. Springs Window Fashions; SWFcontract.

B. Slats: Aluminum; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radius corners.
   1. Width: 1 inch.
   2. Thickness: Not less than 0.008 inch.
   3. Spacing: Manufacturer's standard.
   4. Finish: Ionized antistatic, dust-repellent, baked polyester finish.

C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose operating mechanisms on three sides.
   1. Capacity: One blind per headrail unless otherwise indicated.
   2. Ends: Manufacturer's standard.
   3. Manual Lift Mechanism:
      a. Lift-Cord Lock: Variable; stops lift cord at user-selected position within blind full operating range.
      b. Operator: Extension of lift cord(s) through lift-cord lock mechanism to form cord pull.
   4. Manual Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
      a. Tilt: Full.
      b. Operator: Corrosion-resistant steel rod.
      c. Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over rotation of gear.
   5. Manual Lift-Operator and Tilt-Operator Lengths: Manufacturer's standard.
   6. Manual Lift-Operator and Tilt-Operator Locations: Manufacturer's standard unless otherwise indicated.

D. Bottom Rail: Formed-steel or extruded-aluminum tube that secures and protects ends of ladders and lift cords and has plastic- or metal-capped ends.
   1. Type: Manufacturer's standard. FABRICATION

E. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.
   1. Type: Braided cord.

F. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.
   1. Type: Overhead.
   2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by blind manufacturer for weight and size of blind.

G. Colors, Textures, Patterns, and Gloss:
   1. Slats: As selected by Architect from manufacturer's full range.
   2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated.

2.2 HORIZONTAL LOUVER BLIND FABRICATION

A. Product Safety Standard: Fabricate horizontal louver blinds to comply with WCMA A 100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
   1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less 1/4 inch per side or 1/2 inch total, plus or minus 1/8 inch. Length equal to head-to-sill dimension of opening in which blind is installed less 1/4 inch, plus or minus 1/8 inch.
   2. Outside of Jamb Installation: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
   1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.

D. Mounting and Intermediate Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind placement indicated.

E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

F. Color-Coated Finish:
   1. Metal: For 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.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units according to manufacturer's written instructions.
   1. Locate so exterior slat edges are not closer than 1 inch from interior faces of glass and not closer than 1/2 inch from interior faces of glazing frames through full operating ranges of blinds.
   2. Install mounting and intermediate brackets to prevent deflection of headrails.
   3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

A. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

A. Clean horizontal louver blind surfaces after installation according to manufacturer's written instructions.

B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer and that ensures that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.

C. Replace damaged horizontal louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion.

END OF SECTION

12 24 00

WINDOW SHADES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes furnishing and installing window shades at exterior window vision lights indicated.
   1. Section includes furnishing and installing window shades at all exterior window vision lights within glazing system enframement, surface mounted on head, and extending to sill.
   2. Work excludes vision lights at all exterior doors and sidelights.

1.3 RELATED WORK

A. Related Work of Other Sections:
   1. Section 08 41 00 – Entrances and Storefront

1.4 SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, details of installation, operational clearances, wiring diagrams, and relationship to adjoining Work.
   1. Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
   2. Provide coordination drawings drawn to scale and coordinating penetrations and ceiling-mounted items.

C. Samples: For each exposed finish and for each color and texture required.

D. Window Treatment Schedule: Use same room designations indicated on Drawings.

E. Maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products A qualified installer, approved by manufacturer to install manufacturer's products.

B. Roller Shades Fire-Test-Response Characteristics: Provide products passing flameresistance testing according to NFPA 701 by a testing agency acceptable to authorities having jurisdiction.

C. Corded Window Covering Product Standard: Comply with WCMA A 100.1.

PART 2 PRODUCTS

2.1 ROLLER SHADES

A. Products: Subject to compliance with requirements, provide "M5" standard bracket, regular roll with fascia, ceiling mount shade system by MechoShade Systems, Inc. with ThermoVeil dense weave 1000 series (2 – 3 open), color 1010 light grey, or equivalent Solarfective Products Limited “Teleshade System” with snap-in mounting filter shade, dense weave with 1percent open area, Lutron Fabric, Mermet, Vizela Translucent, color Loutre PF-609-1.
   1. Contact: The Shade Shop, (Tel) 713-623-0750.

B. Shade Operation: Manual; with spring roller continuous loop bead chain, clutch, and cord-tensioner and bracket gear and crank lift operator with appropriate wand length for head mounting height.

2.2 FABRICATION

A. Product Description: Roller shade consisting of roller, a means of supporting roller, flexible sheet or band of material carried by roller, a means of attaching material to roller, bottom bar, and operating mechanism that lifts and lowers the shade.

B. Concealed Components: Noncorrodible 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-degrees 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.

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: Not fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions. Allow clearances for window operation hardware.
   1. Location: Shade band positioned not closer than 2-inches (50-mm) to interior face of glass.

B. Connections: Connect motorized operators to building electrical system.

C. Adjusting: Adjust roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

D. Cleaning: Clean roller shade surfaces after installation, according to manufacturer's written instructions.

END OF SECTION

SECTION 22 00 00
GENERAL REQUIREMENTS 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.

B. Coordinate with Commissioning Requirements indicated in Section 019100. This Contractor is responsible to comply with all requirements for the above section.

1.2 SUMMARY

A. Design a complete plumbing system including all sanitary, waste and vent piping, storm piping, gas piping and all equipment necessary for a complete system and in accordance with all local jurisdictions and codes.

B. A record shall be kept of all permits and inspections and submitted to the Master Plumber. In addition, a list of all equipment and devices will be provided.

C. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
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, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and 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. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. 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: Include Products specified in the following Sections:
1. Section 22 00 00 – General Requirements for Plumbing
2. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping
3. Section 22 05 23 – General Duty Valves for Plumbing Piping
4. Section 22 05 29 – Hangers and Supports for Plumbing Piping
5. Section 22 05 53 – Identification for Plumbing Piping & Equipment
6. Section 22 07 00 – Plumbing Insulation
7. Section 22 08 00 – Commissioning of Plumbing Systems
8. Section 22 11 16 – Domestic Water Piping
9. Section 22 11 19 – Domestic Water Piping Specialties
10. Section 22 11 23 – Domestic Water Pumps
11. Section 22 13 16 – Sanitary Waste Piping
12. Section 22 13 19 – Sanitary Waste Piping Specialties
13. Section 22 14 13 – Facility Storm Water Piping
14. Section 22 20 00 – Natural Gas Piping
15. Section 22 32 00 – Domestic Water Filtration Equipment
16. Section 22 33 00 – Electric Domestic Water Heaters
17. Section 22 40 00 – Plumbing Fixtures
18. Section 22 47 00 – Drinking Fountains and Water Coolers

A. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

B. Mark dimensions and values in units to match those specified.

C. Submit Fabrication Drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these Specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication Drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

D. All required Fabrication Drawings, except as noted otherwise, shall be prepared at a scale of not less than 1/4" = 1'-0". Fabrication Drawings for ductwork, air handling units, and sections in Mechanical Rooms shall be drawn at a minimum scale of 3/8" = 1'-0". Submit three blueline prints of each Fabrication Drawing to the Architect/Engineer for review. Reproduction and submittal of the Construction Documents is not acceptable. The Architect/Engineer will review the drawing and return one (1) print with comments.

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: All materials and distribution, and utilization equipment shall be UL Listed. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. All equipment and materials shall be new, unused and of United States Domestic manufacture.

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."

D. Prepare Coordination / Installation Shop drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
1. Structural floor, wall and roof opening sizes and details
2. Clearances for installing and maintaining insulation.
3. Locations of light fixtures and sprinkler heads.
4. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
5. Equipment connections and support details.
6. Exterior wall and foundation penetrations.
7. Routing of piping.
8. Fire rated wall and floor penetrations.
9. Sizes and location of required concrete pads and bases.
10. Valve stem movement.

1.8 APPLICABLE CODES

A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.

B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.

C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements of the following nationally accepted codes and standards:
   1. Underwriters' Laboratories, Inc., UL.
   2. American Standards Association, ASA.
   3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE.
   4. American Society of Mechanical Engineers, ASME.
   5. American Society of Plumbing Engineers, ASPE.
   6. American Society of Testing Materials, ASTM.
   7. American Water Works Association, AWWA.
   8. International Plumbing and Fuel Gas Codes, 2015 edition with City of Stafford, Texas amendments.
   9. National Bureau of Standards, NBS.
   10. NFPA 70, National Electrical Code, 2017 edition with City of Stafford, Texas amendments.
   11. Texas Accessibility Standards (TAS) - Elimination of Architectural Barriers, Texas Government Code, Chapter 469 administered by the Texas Department of Licensing and Regulation (TDLR), effective March 15, 2012.

D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.

E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.

1.9 DRAWINGS AND SPECIFICATIONS

A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.

B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least seven (7) working days prior to bid opening date for issuance of an addendum.

C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard

product will meet the requirements of the project design, Drawings, Specifications and space constraints.

D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.

E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution by made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing ten (10) days prior to the bid date without fail.

F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.

G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.

H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) and Plumbing Design Documents and all other trades.

I. Coordinate with Division 01 requirements for substitution, unless noted otherwise the Contractors wishing to substitute products, materials or methods from those indicated or specified, shall submit such requests to the Owner or Engineer in writing and within THIRTY (30) WORKING DAYS OF NOTIFICATION OF CONTRACT AWARD. Requests for permission to utilize alternates or substitutions will not be considered after that time, unless the Specified item is unavailable or will adversely affect completion of the Project. Claims submitted for consideration will require notarized letters from all parties involved and will be considered only if the Contractor has been timely in his delivery for review of all required equipment and material submittals. Owner or Engineer will investigate such requests for substitution and if acceptable will issue a letter allowing the substitution.

J. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.

K. Requests shall be bound and shall consist of three (3) sets of descriptive literature and performance data covering each item of equipment or material. The submittal shall include the following:
   1. Manufacturer’s name and phone number
   2. Name of the person submitting the product
   3. Model number
   4. Performance

5. Statement of compliance with specification.
6. Name of the individuals or company originating the submittal.
7. Name of the project for which the submittal is made.
8. An index page of the items submitted.
9. A written list of variations between the specified product and the submitted product.
10. Sufficient information, including scaled drawing of area and equipment involved at a scale of 1/4" = 1'-0" minimum, as required to demonstrate that the alternate or substituted product will fit in the space available.
11. Identification of each item of material or equipment matching that indicated on the Drawings. All applicable industry or national Listings, Labels, Approvals and Standards shall be clearly indicated.
12. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements shall be so indicated. All non-applicable information shall be crossed out.
13. Provide upon request of the Owner or Engineer, samples of materials and/or equipment as may be required.

L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions. The Engineer shall be the sole authority to approve or disapprove any and all substitutions.

M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

1.10 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Special Project Requirements, in addition to the requirements specified in Division 22, indicate the following installed conditions.
1. Duct mains and branches, size and location, for both exterior and interior; locations of dampers, fire dampers, duct access panels, and other control devices; filters, fuel fired heaters, fan coils, condensing units, and roof-top A/C units requiring periodic maintenance or repair.
2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
5. Contract Modifications, actual equipment and materials installed.

B. The Contractor shall maintain a set of clearly marked black line record "AS-BUILT" prints on the job site on which he shall mark all work details, alterations to meet site conditions and changes made by "Change Order" notices. These shall be kept available for inspection by the Owner, Architect or Engineer at all times.

C. Contractor Startup and Commissioning Verification - the system will provide a secure page for each integrated system allowing the contractor responsible for each phase to sign on and certify the status of each piece of equipment.

D. Refer to Division 01 for additional requirements concerning record drawings. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Delivery of as built prints and re-producible is a condition of final acceptance.

E. The record prints shall be updated on a daily basis and shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall include at least two dimensions to permanent structure points.

F. At the Engineer's option, the Contractor shall transfer all data from the record "AS-BUILT" prints to an electronic media such as AutoCAD latest release, in order to plot the reproducible media "AS-BUILT" drawings. Since data stored on electronic media can deteriorate undetected or be modified without the Engineer's knowledge, the AutoCAD electronic drawing files are provided without warranty or obligation on the part of the Engineer as to accuracy or information contained in the files. All information in the files shall be independently verified by the user. Any user shall agree to indemnify and hold the Engineer harmless from any and all claims, damages, losses, and expenses including but not limited to Attorney's fees arising out of the use of the AutoCAD drawing files. Engineer shall furnish to the Contractor electronic media files of Contract Documents for the Contractor to use for inputting of the data from the record "AS-BUILT" prints and the Contractor shall return the revised electronic files on CD ROM properly labeled to the Engineer and shall submit the plotted reproducible drawings and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet as described in paragraph G. below.

G. Contractor shall transfer all marks from record drawings and submit a set of clear concise set of reproducible record "AS-BUILT" drawings and shall submit the reproducible drawings with corrections made by a competent draftsman and three (3) sets of blackline prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineer’s Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet.

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 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.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
   1. Solvent Cements for Joining Plastic Piping:
   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 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. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser Industries, Inc.; DMD Div.
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
      d. JCM Industries.
      e. Smith-Blair, Inc.
      f. Viking Johnson.
   2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
   4. Aboveground Pressure Piping: Pipe fitting.
   5. Manufacturers:
      a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Thompson Plastics, Inc.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC PVC CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO INC.
      b. NIBCO, Inc.; Chemtrol Div.

D. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Fernco, Inc.
      c. Mission Rubber Company.
      d. Plastic Oddities, Inc.

2.5 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. Coordinate subparagraph and associated subparagraphs below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      e. Hart Industries, International, Inc.
      f. Watts Industries, Inc.; Water Products Div.
      g. Zurn Industries, Inc.; Wilkins Div.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.
      d. Watts Industries, Inc.; Water Products Div.

F. 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. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F
   1. Manufacturers:
      a. Calpico, Inc.
      b. Lochinvar Corp.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Perfection Corp.
      b. Precision Plumbing Products, Inc.
      c. Sioux Chief Manufacturing Co., Inc.
      d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   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: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 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 water-stop, 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. Under-deck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 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.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING 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. All cleanouts shall be accessible.

D. Any room that has a plumbing fixture shall have an accessible isolation valve.

E. Provide hot and cold and tempered water isolation valves at every supply pipe to each restroom or restroom bank. Isolation valves shall be accessible in all restrooms. The Contractor shall provide a minimum of 2 feet accessible pipe chase for maintenance. For restrooms with hard ceilings, provide a 24"x24" access panel effectively positioned at “wet” wall for maintenance and inspection purposes.

F. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

I. Install piping to permit valve servicing.

J. Install piping at indicated slopes.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install piping to allow application of insulation.

N. Select system components with pressure rating equal to or greater than system operating pressure.

O. 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. Insulated Piping: One-piece, stamped-steel type with spring clips.
      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 in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      i. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
      j. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

P. Sleeves are not required for core-drilled holes.

Q. Permanent sleeves are not required for holes formed by removable PE sleeves.

R. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

S. 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.
      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.

T. Water and gas lines under drives and walkways shall be sleeved with schedule to PVC, at least two (2) pipe sizes larger than the supply line.

U. 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.

V. 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.

W. 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.

X. Verify final equipment locations for roughing-in.

Y. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

Z. Coordinate setting of equipment with the requirements of other trades so as to avoid conflicts and to insure compatibility. Equipment shall not block access for installation of other equipment.

AA. Set base mounted equipment on permanent and finished supports. Temporary support, if any, shall be removed prior to making final pipe, duct, or electrical connections to equipment.

BB. Adjust suspended equipment to final elevation prior to making pipe, duct or electrical connections.

CC. Exercise caution during equipment placing operations to ensure that structure is not overloaded.

DD. Do not move heavy equipment across floor or roof of insufficient load bearing capacity to support such equipment. Provide bracing or shoring as required or use crane to place equipment directly on permanent and finished support.

EE. Secure all roof mounted equipment to the structure adequately to resist overturning, uplift and sliding forces for the following wind design criteria:
   1. Ultimate Wind Speed: 147mph, 3-second gust.
   2. Exposure: B.
   3. Risk Category: III.

3.2 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. 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.

G. Welded Joints:
   1. Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
   2. All necessary precautions shall be taken as required to prevent damage to the roofing due to welding or cutting of pipe. Any damage shall be repaired by the roofing contractor, payment of which will be made by the responsible party. Extent and nature of repairs necessary will be as approved by Stafford MSD Construction Services Division.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Non-pressure Piping: Join according to ASTM D2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.

K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D3212.

3.3 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. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 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.

3.5 PAINTING

A. Painting of plumbing 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.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
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."

3.7 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.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Wood supports are not allowed.

3.9 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 22 00 00

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SECTION 22 05 23
GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Valves for building plumbing service piping.

1.2 REFERERENCES

A. AGA Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.

B. AWS - Welding and Brazing Qualifications.

C. MSS SP-67 - Butterfly Valves.

D. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.

E. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

F. MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends.

G. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

A. Product Data: Submit Manufacturers catalog information with valve data and ratings for each service.

B. Welders Certificate: Include welder’s certification of compliance with ASME SEC IX.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

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

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves.

B. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of Texas and authority having jurisdiction codes and standards.

B. Maintain one (1) copy of each document on site.

C. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three (3) years documented experience, and with service facilities within 100 miles of Project.

D. Welding Materials and Procedures: Conform to ASME SEC 9.

E. Conform to ASME B31.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install valves underground when bedding is wet or frozen.

1.8 WARRANTY

A. Provide five-year manufacturer warranty for valves excluding packing.

1.9 EXTRA MATERIALS

A. Supply two (2) packing kits for each size valve.

B. Provide one (1) master flow meter for this project, to become the property of the Owner.

C. Provide a hand-held, portable meter which instantaneously displays flow and/or changes in flow by means of a high-visibility, integral, backlit LCD that displays flow rate in GPM. Charts and tables are not allowed.

PART 2 - PRODUCTS

2.1 VALVES

A. Manufacturers
   1. Ball and Butterfly Valves
      a. Keystone
      b. Milwaukee
      c. Nibco
   2. Butterfly Valves
      a. Keystone
      b. Nibco
   3. Check Valves
      a. Nibco
      b. Watts

B. General
   1. Provide valves of same manufacturer throughout the project where possible.
   2. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
   3. Valve Connections
      a. Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use line pipe size valves.
      b. Threaded pipe sizes 2 inches and smaller.
      c. Flange pipe sizes over 2 inches.
      d. Solder or screw to solder adapters for copper tubing.
      e. Use grooved coupling for grooved end pipe.
   4. Check Valves

a. 2 Inches and Smaller: Spring loaded in-line check valve; Nibco 480 series, or Watts 600 series.
b. Over 2 Inches: Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends; Nibco F-908 series or Watts 410 series
c. Discharge of Pumps: 150 psi W.O.G., iron body, replaceable bronze disc and seat, globe disc design, 316 S.S. spring, flange connections.

C. Butterfly valves (4" and larger only) must be full-lug body type. Valves 4" through 12" must be rated for 200 psi at 175 degrees F.; valves 14" through 36" must be rated for 150 psi at 200 degrees F. Valves must meet ANSI Class 125/150 flange standards and MSS SP-67 standards.
1. Valve body construction must be ductile iron.
2. Seat must be dovetail, or tongue-in-groove, EPDM seat designed to ensure bubble-tight, bi-directional shutoff and must be field replaceable. Seat must be designed to fully isolate the valve body, stem and journal areas from the flowing media. Buna-N seat must be used for thermal storage and glycol systems.
3. Disc/Stem - The valve must have a one-piece disc/stem assembly or other positive mechanical engagement design for minimum obstruction to flow. Use of pins or bolts exposed in the waterway to attach disc to stem are not allowed. Material for disc and stem must be 316 stainless steel. The disc edges and hubs must be hand polished to a 32 AARH or better finish.
4. Inboard Bearings/Upper Steam Busing/Stem Packing - The valve must have upper and lower inboard stem bearings isolated from the line media, a heavy duty upper stem bushing, and bi-directional stem packing to ensure dry stem design.
5. Operator must have an integral cast top plate for direct flush-mounting of manual operator or actuator without use of brackets or adapters. Provide 4" and 6" valves with lever-lock type operator. Provide valves 8" and larger with manual gear operators.

D. Drain Valves: Bronze compression stop with nipple and cap or hose thread.
1. Pressure Ratings: Unless otherwise indicated, use valves suitable for 125 minimum psig WSP at 450 degrees F and maximum 200 psig at 250 degrees F.

E. Ball Valves:
1. 2 Inches and Smaller: Bronze body, full port, 316 S.S. ball and stem, reinforced Teflon seats, separate packnut with adjustable stem packing, 600 psi W.O.G., solder or threaded ends. Valve ends must have full depth ANSI threads or extended solder connections and conform to MSS SP-110. Provide with balancing stops and non-metallic stem extensions for pipe insulation.
2. Over 2 Inches: Carbon steel body, 316 S.S. ball and stem. Teflon seat and stuffing box seal, conventional bore, Class 150 and conforming to MSS SP-72, lever handle, flanged ends, and balancing stops.
3. All ball valves for fuel gas service shall be AGA or U.L. and City of Houston approved. Milwaukee Butterball valves are acceptable.

F. Manual Valve Operators
1. Provide suitable handwheels for gate, ball and drain valves.
2. For butterfly valves provide gear operators for sizes 8 inches and larger. For smaller sizes, provide lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock nut and memory stop for throttling service.
3. Provide valves located more than 6 feet from floor in equipment room areas with chain wheel operators. Extend chains to approximately 5 feet above floor and provide hook type tie back clips arranged to retain chain clear of walking aisles.

G. Pressure Reducing/Pressure Sustaining Valve:
1. 400 psi W.O.G., bronze body, globe design, bolted bonnet, bronze pilot control, S.S. trim, Buna N disc. Provide with solenoid control, solenoid by-pass cock, flow clean strainer,

isolation valve, check valve with cock, position transmitter, independent operating pressure, atmospheric drain, electronic controller, CV flow controls and Y-strainer.

2. The valve controller shall provide the interface between a remote computer system and the control valve. The controlled parameter signal shall be accepted through a 4-20 mA feedback signal. Local manual set point control and full manual control of control valve solenoids is to be provided on the controller panel for local control.
3. Upon receiving the set point command signal from the remote computer system, the controller will signal the valve to move and maintain the valve at the desired set point. A vacuum fluorescent display of current status and set-point value in scalable engineering units shall be supplied.
4. The controller shall compare set-point and feedback values and adjust the valve accordingly to achieve the set-point. When the feedback signal deviates from the set-point value, the appropriate opening or closing solenoid on the control valve shall activate. As the feedback signal approaches the set-point, the solenoid output will pulse on and off to gradually return the measurement to set-point. One solid state relay energizes for measurements condition below the set-point while the other energizes for measurement greater than set-point. These outputs shall be wired direct or through intermediate relays to the opening and closing solenoids on the control valve. Solenoid output indicator lights shall illuminate when either the open or closed solenoid is activated.
5. The total cycle time between each pulse shall be programmable between 1 and 60 seconds. The duration of each pulse shall be directly proportional to the deviation from set-point outside of dead band. The time proportioned outputs shall be independently adjustable for conditions above and below the set-points to properly tune valve response. The time proportional output band width shall be independently programmable between 1 and 200 percent of full scale. When the feedback signal returns within the deadband zone, the valve will maintain position. Provision shall be made to open/close/maintain position in the event of a loss of the feedback signal.
6. The operator interface shall consist of two rows of alphanumeric characters to display numeric values and units. Color coded alarm, status and mode indicators shall inform the operator of operating conditions. Security key codes shall protect against undesired changes to the controller. All programming shall include keywords and prompts to aid in setup and tuning the controller.
7. The controller shall be all solid state construction with the internal chassis capable of being removed for inspection and adjustment. All program memory including set-point and tuning parameters shall be protected by an internal lithium battery rated for ten (10) year life.
8. Remote communications shall be accepted through a 4-20 mA DC analog set-point signal. The controller shall monitor the set-point signal. When local control is selected, the set-point shall be changed at the controller keypad.
9. The controller shall be capable of direct linkage to a computer or other instrumentation, which has RS-232C or RS-422 communications. When RS-422 data highway communications is specified, up to 64 controllers may be addressed from a single computer port and shall operate up to 5,000 from the computer, RS-232C shall operate up to 50' distance between the computer or TRU and the valve controller. All set-point, tuning, and auto-manual operation shall be adjustable remotely from the computer. All commands shall consist of ASCII mnemonic commands sent from the computer. Each transmission shall include the individual controller address. Communication baud rates shall be 300, 1,200, or 2,400 baud.
10. The Electronic Valve Controller shall be the Cla-Val Model 131 VC Valve Controller as manufactured by Cla-Val, Co. or approved equal.

2.2 AIR VENTS

A. Manufacturers:
   1. Bell and Gossett.
   2. Taco.

3. Watts.
4. Armstrong.

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8-inch brass needle valve at top of chamber.

C. Float Type: Brass, cast iron or semi-steel body, copper or stainless steel float, stainless steel valve and valve seat; suitable for system operating temperature and pressure (minimum 125 psig); with isolating valve.

2.3 STRAINERS

A. Manufacturers:
1. Keckley.
2. Mueller.
3. Strainers, Inc.
4. Victaulic.
5. Grinnell.

B. 2 Inches and Smaller: Screwed brass or iron body for 150 psig working pressure, Y pattern with 1/32-inch stainless steel perforated screen.

C. 2-1/2 Inches to 4 Inches: Flanged iron body for 150 psig working pressure, Y pattern with 3/64-inch stainless steel perforated screen.

D. Over 4 Inches: Flanged iron body for 150 psig working pressure, basket pattern with 1/8-inch stainless steel perforated screen.

E. Provide grooved couplings for grooved end pipe.

2.4 RELIEF VALVES

A. Manufacturers:
1. Bell and Gossett.
2. Taco.
3. Watts.
4. Armstrong.

B. Bronze body, Teflon seat, stainless steel stem and springs, minimum 3/4", automatic, direct pressure actuated, capacities ASME certified and labeled, set at factory for 45 psig, unless otherwise required by system.

C.

2.5 PRESSURE REDUCING VALVES

A. Manufacturers:
1. Bell and Gossett.
2. Taco.
3. Watts.
4. Armstrong.

B. Bronze body, removable cartridge seat assembly, bronze internal parts; with built-in strainer, built-in back pressure check valve and adjustable filling valve pressure. Valves shall be minimum 3/4" and factory set for 25 psi.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. After completion, fill, clean, and treat systems.

3.2 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space and other work.

C. Group piping whenever practical at common elevations.

D. Install piping with pipe rollers, guides, anchors, and expansion loops as required to allow for expansion and contraction without stressing pipe, joints, or connected equipment; refer to Section 22 05 16.

E. Provide clearance for installation of insulation, and access to valves and fittings.

F. Provide access where valves and fittings are not exposed.

G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

I. Prepare pipe, fittings, supports, and accessories for primer coat painting prior to insulation; refer to Section 22 07 00. Prepare pipe, fittings, supports, and accessories for primer coat, undercoat, and finish coat painting for all uninsulated piping; refer to Section 22 11 16.

J. Use grooved mechanical couplings and fasteners only in equipment rooms.

K. Install unions downstream of valves and at equipment or apparatus connections.

L. Install brass male adapters each side of valves in copper piped system. Sweat solders adapters to pipe.

M. Water supply valves:
   1. 1/4" to 2" size: ball valves.
   2. 2-1/2" and larger: ball or butterfly valves (butterfly valves shall be lug style only)

N. Provide isolation valves in main domestic water lines in building to isolate sections of the building.

O. Provide isolation valves at each fixture group.

P. Locate valves over accessible areas as practical. Coordinate location with architectural features so that the valves are operable and accessible.

Q. When located above ceiling, provide easy access to horizontal stem. Locate valves within 18" of ceiling so that they are within reach.

R. Coordinate with Owner an acceptable way of subtly marking the location of valves, such as a thumbtack on an acoustical ceiling tile.

S. Provide 3/4-inch ball drain valves at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest drain.

T. Install pre-insulated underground pipe in total compliance with the manufacturer's recommendations. Provide pipe casing and sleeves at slab-on-grade penetrations in total compliance with Section 22 05 29 (No Exceptions).

U. Test piping in compliance with the requirements of Division 1 and Section 22 11 16.

V. Install specialties in accordance with manufacturer's instructions to permit intended performance.

W. Provide manual air vents at system high points readily accessible.

X. Provide automatic air vents in ceiling spaces or other high or concealed locations, provide vent tubing to nearest drain.

Y. Provide valved drain and hose connection on strainer blow down connection.

Z. Provide a relief valve on discharge side of pumps.

AA. Select system relief valve capacity so that it is greater than system operating pressure.

BB. Pipe relief valve outlet to nearest floor drain.

CC. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

DD. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

EE. Support pump fittings with floor mounted pipe and flange supports.

FF. Provide flow metering stations where indicated on the Drawings. Furnish the TAB Contractor with the flow meter to be used in performing his work. After completion of all TAB work, turn the flow meter over to the Owner's personnel for their use. Provide the Owner with a schematic drawing indicating the location of all flow metering stations and the design flow rate for each station. Instruct the Owner's personnel in the proper use of the flow metering equipment.

GG. Provide thermometer and pressure gauges for all equipment and/or as shown on the drawings.

HH. Insulate piping as required by Section 22 07 00.

II. Pipe make-up line with pressure reducing and pressure relief valves to air separator fitting. Provide quick-fill/bypass line as shown on the drawings.

JJ. Insulate equipment as per Section 22 07 00.

KK. Label all valves with bronze punched data plate. Plate shall be a minimum of six inches diameter.

END OF SECTION 22 05 23

SECTION 22 05 29
HANGERS AND SUPPORTS 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 hangers and supports for plumbing system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Pipe positioning systems.
   8. Equipment supports.

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 "Sprinklers Systems" 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 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Mechanical expansion fastener systems.
   4. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to 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. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

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. Available Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Carpenter & Paterson, Inc.
3. Globe Pipe Hanger Products, Inc.
4. Anvil International Corp.

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 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.

2.3 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Acceptable Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Acceptable Manufacturers:
   1. Engineered Products, Inc.
   2. Insulation Carpenter & Paterson, Inc.
   3. ERICO/Michigan Hanger Co.
   4. PHS Industries, Inc.
   5. Pipe Shields, Inc.
   6. Rilco Manufacturing Company, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Acceptable Manufacturers:
      a. B-Line Systems, Inc.; a division of Cooper Industries.
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.

2.6 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. All piping on roof shall be supported by roof mounted pipe supports. ***No wood is allowed***.

C. All Pipe support system on roof shall be sized / designed by manufacturer and installed by this Contractor. The pipe support system shall be suitable for the insulated chilled water and hot water piping system as indicated on drawings. Pipe support system must meetthe following requirements:
   1. Bottom of the pipe must be 18" above roof finished level.
   2. Pipe support spacing shall be based on the maximum roof load of 2.5 #/sq-inch. Contractor must size the pedestal base area for each support in coordination with the required support spacing such that the total load on roof does not exceed 2.5 #/sq-inch.

3. Submit the proposed scheme to the engineer for approval before material procurement or installation of any work.
4. Contractor is responsible to price all the support system at the project bid stage.
5. Contractor is responsible to coordinate all the support system with the roofing drawings of this package.
6. Provide expansion loops and floating support system in accordance with requirements.
7. The support channels and plate frames indicated on the drawings are the required minimum standards. Support system vendor must verify the loads on each section and upgrade as necessary.

D. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
1. Acceptable Manufacturers:
a. ERICO/Michigan Hanger Co.
b. MIRO Industries.
c. PHP Systems

E. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
1. Acceptable Manufacturers:
a. MIRO Industries (or equal).
b. PHP Systems

F. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
1. Acceptable Manufacturers:
a. ERICO/Michigan Hanger Co.
b. MIRO Industries.
c. Portable Pipe Hangers.
2. Base: Plastic.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

G. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
1. Acceptable Manufacturers:
a. Portable Pipe Hangers.
b. MIRO Industries.
c. Portable Pipe Hangers
2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

H. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. 1. Acceptable Manufacturers:

1. C & S Mfg. Corp.
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Samco Stamping, Inc.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Non-staining, noncorrosive, and nongaseous.
   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 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 padded hangers for piping that is subject to scratching.

F. 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 non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
   3. Carbon or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. 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.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weld-less Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. 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 fabricated from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. 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.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

L. 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.

M. Install lateral bracing with pipe hangers and supports to prevent swaying.

N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

O. Load Distribution: Install hangers and supports so 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 so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

Q. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inch long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood inserts.
   6. Insert Material: Length at least as long as protective shield.
   7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

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 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.

3.5 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. 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.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 22 05 29

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SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.

1.3 RELATED SECTIONS

A. Section 09 91 00 – Painting: Identification painting.

1.4 REFERENCES

A. ANSI A13.1 - Scheme for the Identification of Piping Systems.

B. IPC - International Plumbing Code, 2015 edition.

1.5 SUBMITTALS

A. Submittals in this article are defined in Division 01 Section "Submittal Procedures" as "Action Submittals."

B. Submit under provisions of Section 22 00 00.

C. Submit list of wording, symbols, letter size, and color coding for plumbing identification.

D. Product Data: Provide manufacturers' catalog literature for each type of product required, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

E. Samples: Submit two (2) of each type of label, tag, etc., of the approximate size specified or implied in the Specification for color, letter style, and graphic representation.

F. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for plumbing equipment, piping and valve identification.
1. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
2. Access Panel and Door Markers: Provide a schedule of all panels and doors to be labeled with the proposed content for each label.
3. Pipe Label Schedule: Provide a schedule of each piping systems indicating a proposed nomenclature and location of all pipe markers.

G. Valve Chart and Schedule: Provide a proposed valve numbering scheme and schedule for each piping system, including valve tag number, location, function, and valve manufacturer's name and model number, piping system, system abbreviation as shown on tag, normal-operating position (open, closed, or modulating), and variations for identification, to include in maintenance manuals. Mark valves intended for emergency shut-off and similar special uses.

H. Warning Tags: Provide a schedule of all equipment to be labeled with the proposed content for each label.

I. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.6 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.

1.7 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 22 00 00.

B. Record actual locations of tagged valves and update schedules accordingly.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five (5) years documented experience

B. Installer Qualifications: Company specializing in performing Work of this section with minimum five (5) years documented experience.

C. ASME Standards: Comply with ASME A13.1 for color scheme, lettering size, length of color field, and viewing angles of identification devices.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging with labels clearly identifying product name and manufacturer until ready for installation.

B. Storage: Store materials in clean, dry area indoors until ready for installation.

C. Handling: Protect materials and finish from damage during handling and installation.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them.

All items of equipment such as fire pumps, etc., are to be clearly marked using engraved nameplates as specified. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner's Designated Representative.

C. General: Provide manufacturer's standard products of categories and types required for each application specified. For each identification type, provide all products from same manufacturer with same text, style, color, shape, and other identification features.
   1. Provide nameplates with the unit number on all plumbing equipment.
   2. Access panel and door markers for valve cabinets, etc.
   3. Provide pipe identification labels including direction-of-flow arrows and with service indicated. All labels shall have background colors matched with specific service designation.
   4. Provide valve tag numbers on all valves.
   5. Warning tags at motors and equipment controlled by automatic starters, etc.

2.2 MANUFACTURERS

A. Equipment Tags, Valve Tags, and Markers:
   1. Brady Corporation.
   2. Brimar Industries.
   3. Craftmark.
   4. Graphic Products, Inc.
   5. Marking Services, Inc.
   6. Seton, owned by Brady Corporation.

2.3 MATERIALS

A. Color: Meet requirements of ANSI A13.1, unless specified otherwise.

2.4 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness:
      a. Indoors: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
      b. Outdoors: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 1 by 3 inches.
   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 (2/3) to three-fourths (3/4)the size of principal lettering.
   7. Fasteners: Stainless-steel self-tapping screws.

B. Label Content: Nomenclature on the label is to include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner..

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, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

D. All scheduled equipment shall be identified with an Equipment Tag.

2.5 ACCESS PANEL AND DOOR MARKERS

A. Material and Thickness: 1/8-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification.

B. Letter Color: White

C. Background Color: Black

D. Fasteners: Self-tapping, stainless steel screws or contact-type, permanent adhesive.

2.6 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.7 PIPE LABELS (INDOOR PIPING)

A. Provide labels for above ground piping located indoors, and not exposed to sunlight or a harsh environment.

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction in conformance with ANSI A13.1.

B. Plastic Labels for Pipe O.D. less than 8 inches: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe or pipe covering and to attach to pipe without fasteners or adhesive in contact with the pipe surface.

B. Pipe Labels for Pipe O.D. 8 inches and Over: Strap-on, semi rigid plastic to cover partial circumference of pipe and to attach to pipe with nylon ties.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

D. Pipe markers and arrow markers also shall be provided for all piping systems.

2.8 PIPE LABELS (OUTDOOR PIPING)

A. Provide labels for above ground piping located outside, and exposed to sunlight or a harsh environment, the following product is specified.

B. Pre-printed, color-coded, with lettering indicating service, and showing flow direction.

C. Pipe markers shall be constructed of printed 5 mil polyester and top laminated with ultraviolet and chemical resistant plastic film that is engineered to provide maximum durability of the printed legend. Markers shall be pre-coiled to wrap entirely around the circumference of pipe up to 10 inch outside diameter, and self-sealed with a strip of clear ultraviolet and chemical resistant plastic film. Coiled markers shall seal to themselves, and not the pipe surface.

D. Pipe Labels for pipe O.D. up to 10 inches: Shall be labeled with a single piece, pre-printed marker that wraps entirely around the circumference of the pipe, overlaps and seals to itself rather than adhere to the pipe surface.

E. Pipe Labels for pipe O.D. 10 inches and greater: Shall be constructed of printed 5 mil polyester and top laminated with clear ultraviolet and chemical resistant plastic film that is pre-applied to an acrylic-faced, co-extruded ABS plastic carrier. Carrier shall have pre-formed legs running the entire length of the part to ensure marker remains straight and aligned with pipe. Flow direction shall be identified by application of a separate arrow label of same construction. Carriers shall be affixed to piping by means of two (2) stainless steel straps that wrap entirely around the circumference of the pipe.

F. Underground Plastic Pipe markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.9 VALVE TAGS

A. Provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above.

B. Valve tags shall conform to ANSI A13.1.

C. Valve Tags (Indoor): Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Background Color: Natural brass.
   3. Letter Color: Black.
   4. Tag Size: 1-1/2 inches, round.
   5. Fasteners: Brass S-hooks and Jack chain

D. Valve Tags (Outdoor):
   1. Material: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate, and having stainless steel grommet protected predrilled holes with for attachment hardware.

2. Background Color: Red.
3. Letter Color: White.
4. Tag Size: Minimum 1-1/2 inches.
5. Fasteners: Stainless steel S-Hooks and stainless steel Jack Chain.

E. Valve Schedules:
1. 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.
2. Valve-tag schedule shall be included in operation and maintenance data.

2.10 CEILING TACKS

A. Description: Steel with 3/4 inch or 7/8" diameter color coded head.

B. Color code: Red.

2.11 CEILING GRID TAG FOR EQUIPMENT LOCATED ABOVE LAY-IN CEILING

A. Description: 3/4" x variable length vinyl label, 3.0 mil self-adhesive vinyl similar to Graphic Products, Inc. DuraLabel Pro™. Label color shall be black text on a white background.

B. All scheduled equipment above finish lay-in ceiling shall be identified with an Equipment Tag.

C. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

2.12 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds (2/3) to three-fourths (3/4) the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

H. In paragraph below, describe required label content. The objective of labeling equipment is to coordinate it with Drawings, including plans, details, and schedules. This will allow other information, such as capacities and operating characteristics, to be obtained.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.13 WARNING TAGS

A. Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

B. Size: 3 by 5-1/4 inches minimum.

C. Fasteners: Reinforced grommet and wire or string.

D. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

E. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Install identifying devices after completion of coverings and painting.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. A. Thoroughly clean all surfaces to be painted as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping must be completely dry at the time of application. The painting of piping associated with an operating system is strictly prohibited. Site touch-up of the factory applied coating or paint, to include preparation and painting of field welds, must be completed and approved by the Engineer prior to installation of insulation (No Exceptions).

B. For pipe markers that are pre-coiled or strap-on type and do not adhere directly to the piping, no surface preparation is necessary.

3.3 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.4 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.5 ACCESS PANEL AND DOOR MARKERS INSTALLATION

A. Install or permanently fasten markers on access panels and door for fire suppression equipment.

B. Locate labels where accessible and visible.

3.6 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. All plumbing piping shall be labeled to identify the system. 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 other spaces not visible to building occupants but accessible to maintenance personnel); and exterior exposed locations as follows:
   1. Near each valve and control device to indicate proper identification of pipe contents. Where several valves exist on one (1) header, it is necessary to mark only the header.
   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. Every 20 feet in exposed and concealed areas on all piping systems. Provide at least one (1) pipe marker in each room on all piping systems.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

C. Provide a double-ended arrow marker when flow can be in either or both directions.

D. Install plastic tape, and pipe markers completely around pipe in accordance with manufacturer's instructions.

E. Locate markers on the two (2) lower quarters of the pipe where view is unobstructed.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

3.7 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. Other valve-tag sizes, shapes, colors, and letter colors may be available if required.
   2. Valve-Tag Size and Shape:
      a. Cold Water: 1-1/2 inches, round.
      b. Hot Water: 1-1/2 inches, round.
      c. Low-Pressure Compressed Air: 1-1/2 inches, round.
   3. Select contrasting valve-tag color and letter color in two subparagraphs below for each service. Retain "Natural" option for brass or stainless-steel valve tags.
   4. Valve-Tag Color:
      a. Cold Water: Natural.
      b. Hot Water: Natural.
   5. Letter Color:
      a. Cold Water: Black.
      b. Hot Water: Black.

3.8 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.9 CEILING TACKS

A. Mark location of equipment or valves located above ceilings with identifying "buttons" to help in identification for maintenance.

3.10 CEILING GRID TAGS

A. Provide ceiling grid tags to locate valves or other concealed equipment above T-bar type panel ceilings. Locate in corner of grid closest to equipment.

3.11 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.12 VALVE CHART AND SCHEDULE

A. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install one (1) in each individual equipment room at locations as directed A/E or Owner.

B. Provide full piping graphics design in aluminum frame with clear plastic shield. Install one (1) in each individual equipment room at locations as directed by A/E or Owner.

3.13 COLOR CODE FOR MARKING PIPE

Material	Band	Color	Letters & Arrows	Legend
Cold Water (Potable)	Dk. Blue	SW 4056	White	POTABLE
Non-Potable Water	Dk. Blue	SW 4056	White	NON-POT
Fire Protection Water	Red	SW 4081	White	FIRE PR.
Hot Water (Domestic)	Green	SW 4085	White	H.W.
Hot Water Recirculating (Domestic)	Green	SW 4085	White	H.W.R.

3.14 COLOR CODE MARKING SIZES

Outside Diameter of Pipe Covering (Inches)	Length of Color Band (Inches)	Arrow Length by Width (Inches)	Size of Legend Letters and Numerals (Inches)
Less than 1-1/2	8	8 x 2-1/4	1/2
1-1/2 to 2-3/8	8	8 x 2-1/4	3/4
2-1/2 to 7-7/8	12	8 x 2-1/4	1-1/4
8 to 10	24	12 x 4-1/2	2-1/2

Outside Diameter of Pipe Covering (Inches)	Length of Color Band (Inches)	Arrow Length by Width (Inches)	Size of Legend Letters and Numerals (Inches)
Over 10	32	12 x 4-1/2	3-1/2

END OF SECTION 22 05 53

SECTION 22 07 00
PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Cellular glass.
      b. Flexible elastomeric.
      c. Mineral fiber.
      d. Phenolic.
   2. Insulating cements.
   3. Adhesives.
   4. Mastics.
   5. Lagging adhesives.
   6. Sealants.
   7. Factory-applied jackets.
   8. Field-applied jackets.
   9. Tapes.
   10. Securements.
   11. Corner angles.

1.3 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 23 Section "HVAC Insulation."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties, equipment connections, and access panels.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.
   8. Detail field application for each equipment type.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
   1. Sample Sizes:
      a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.

b. Sheet Form Insulation Materials: 12 inches square.
c. Jacket Materials for Pipe: 12 inches long by NPS 2.
d. Sheet Jacket Materials: 12 inches square.
e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Qualification Data: For qualified Installer.

E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
1. Piping Mockups:
a. One (1) 10-foot section of NPS 2 straight pipe.
b. One (1) each of a 90-degree threaded, welded, and flanged elbow.
c. One (1) each of a threaded, welded, and flanged tee fitting.
d. One (1) NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
e. Four (4) support hangers including hanger shield and insert.
f. One (1) threaded strainer and one flanged strainer with removable portion of insulation.
g. One (1) threaded reducer and one welded reducer.
h. One (1) pressure temperature tap.
i. One (1) mechanical coupling.
2. Equipment Mockups: One (1) tank or vessel.
3. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
4. Notify Architect seven (7) days in advance of dates and times when mockups will be constructed.
5. Obtain Architect's approval of mockups before starting insulation application.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
8. Demolish and remove mockups when directed.

1.6 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.

1.7 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.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
1. Armstrong World Industries, Inc.
2. Certainteed Corp.
3. Knauf Fiber Glass GmbH.
4. Owens-Corning Fiberglas Corp.
5. FGH Fabricators, Inc.

B. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

2.2 PIPING INSULATION MATERIALS

A. Fiberglass Piping Insulation: ASTM C547, Class 1 unless otherwise indicated. (Indoor locations).

B. Cellular Glass Insulation: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide the following provide one of the following:
      a. Cell-U-Foam Corporation; Ultra-CUF.
      b. Owens Corning Corporation; Foamglas Super K.
   2. Block Insulation: ASTM C552, Type 1.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
   5. Preformed Pipe Insulation with Factory-Applied ASJ ASJ-SSL: Comply with ASTM C552, Type II, Class 2.
   6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

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 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 Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; All-Service Duct Wrap.

E. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type V, without factory-applied jacket.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Johns Manville; HTB 23 Spin-Glas.
      b. Owens Corning; High Temperature Flexible Batt Insulations.

F. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide 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 C547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C1393, Type II

or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

H. Phenolic:
1. Products: Subject to compliance with requirements, provide the following:
   a. Kingspan Corp.; Koolphen K.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C450 and ASTM C585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
   a. Preformed Pipe Insulation: ASJ.
   b. Board for Equipment Applications: ASJ.

I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Armacell LLC; Tubolit.
   b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
   c. RBX Corporation; Therma-cell.

J. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Styrofoam.
   b. Knauf Insulation; Knauf Polystyrene.

K. Jackets for Piping Insulation: ASTM C921, Type I (vapor barrier) for piping with temperatures below ambient, Type II (water vapor permeable) for piping with temperatures above ambient. Type I may be used for all piping at Installers option.
1. Encase pipe fittings insulation with one-piece pre-molded 16 mil aluminum fitting covers, fastened as per manufacturer's recommendations.
2. Encase exterior piping insulation with 16 MIL aluminum jacket with "Z" closures for weather-proof construction.

L. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

M. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated. White all service jacket "ASJ" vapor barrier with dual self-seal strips for all insulation except flexible unicellular.

2.3 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Insulco, Division of MFS, Inc.; Triple I.
      b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
   3. Products: Subject to compliance with requirements, provide one of the following:
      a. Insulco, Division of MFS, Inc.; SmoothKote.
      b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
      c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-96.
      b. Foster Products Corporation, H. B. Fuller Company; 81-33.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H. B. Fuller Company; 85-75.
      d. RBX Corporation; Rubatex Contact Adhesive.

D. 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.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-96.
      b. Foster Products Corporation, H. B. Fuller Company; 97-13.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

G. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Speedline Vinyl Adhesive.

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, provide the following:
a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
d. Marathon Industries, Inc.; 550.
e. Mon-Eco Industries, Inc.; 55-50.
f. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-52.
b. Foster Products Corporation, H. B. Fuller Company; 81-42.
c. Marathon Industries, Inc.; 130.
d. Mon-Eco Industries, Inc.; 11-30.
e. Vimasco Corporation; 136.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.7 SEALANTS

A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.
   f. Vimasco Corporation; 750.
2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-70.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for equipment and pipe.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.

2.10 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.11 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto PVC Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.12 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.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.13 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: 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.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. 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, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
      2) GEMCO; Press and Peel.
      3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: 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-backed base with a peel-off protective cover.
6. 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, provide one of 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.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO.
      2) Midwest Fasteners, Inc.

2.14 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

2.15 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-52.
      b. Foster Products Corporation, H. B. Fuller Company; 81-42.
      c. Marathon Industries, Inc.; 130.
      d. Mon-Eco Industries, Inc.; 11-30.
      e. Vimasco Corporation; 136.
   3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
   4. Service Temperature Range: Minus 50 to plus 180 deg F.
   5. Color: White.

2.16 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 30-45.
      c. Marathon Industries, Inc.; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Pittsburgh Corning Corporation; Pittseal 444.
      f. Vimasco Corporation; 750.
   2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-70.

b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.17 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.18 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for equipment and pipe.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.

2.19 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.20 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto PVC Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Surefit.
      c. RPR Products, Inc.; Insul-Mate.
   2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      a. Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:
   1) Same material, finish, and thickness as jacket.
   2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   3) Tee covers.
   4) Flange and union covers.
   5) End caps.
   6) Beveled collars.
   7) Valve covers.
   8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.21 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.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
      b. Compac Corp.; 130.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
      d. Venture Tape; 1506 CW NS.
      e. <Insert manufacturer's name; product name or designation.>
   2. Width: 2 inches.

3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.22 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.

3) Midwest Fasteners, Inc.; Cupped Head.
4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: 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.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. 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, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
      2) GEMCO; Press and Peel.
      3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: 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-backed base with a peel-off protective cover.
6. 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, provide one of 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.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:

1) GEMCO.
2) Midwest Fasteners, Inc.

2.23 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

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.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of 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. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches O.C.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches O.C.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches O.C. in both directions.
d. Do not over compress insulation during installation.
e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.
g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two (2) circumferential girdles 12 inches O.C. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches O.C. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, hand holes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, hand holes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum, at least 0.040 inch 0.050 inch 0.060 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular

surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe

insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches O.C.
   4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches O.C.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.10 PHENOLIC INSULATION INSTALLATION

A. General Installation Requirements:
   1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
   2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches O.C.
   4. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.11 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.12 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

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, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed section of polystyrene insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.13 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches O.C. and at end joints.

3.14 FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Two (2) finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
   2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.16 PLUMBING PIPING SYSTEM INSULATION

A. Insulation Omitted: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, buried piping, fire protection piping, and pre- insulated equipment.

3.17 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Domestic hot-water pump insulation shall be one of the following:
1. Cellular Glass: 2 inches thick.
2. Phenolic: 1 inch thick.

D. Domestic cold water, and domestic hot-water hydro-pneumatic tank insulation shall be one of the following:
1. Cellular Glass: 1-1/2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Pipe and Tank: 1 inch thick.

E. Domestic hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:
1. Cellular glass.
2. Mineral-fiber pipe and tank.
3. Phenolic.

F. Provide an insulated enclosure for all backflow preventers, outdoors, above grade. Similar to Hubbell “Lok Box” or Watts “WattsBox”.

3.18 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.19 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
1. NPS 1 and Smaller: Insulation shall be one of the following:
   a. Outdoors: Phenolic Foam: [**<insert>**] inches thick.
   b. Indoors: Fiberglass: [**<insert>**] inch thick.
2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
   a. Outdoors: Phenolic Foam: [**<insert>**] inches thick.
   b. Indoors: Fiberglass: [**<insert>**] inch thick.

3. Provide thermal pipe insulation on all cold water lines subject to freezing, main water entry pipe for 50 linear feet within building and within exterior walls out to five feet into plenum.
4. Insulate entire wall hydrant box, valve and piping in exterior walls.

B. Domestic Hot water and Re-circulated Hot Water:
1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
a. Outdoors: Phenolic Foam: [**<insert>**] inches thick.
b. Indoors: Fiberglass: [**<insert>**] inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
a. Outdoors: Phenolic Foam: [**<insert>**] inches thick.
b. Indoors: Fiberglass: [**<insert>**] inch thick.
3. Provide thermal pipe insulation on all piping carrying domestic hot water.

C. Storm water and Overflow:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.
2. Insulate all roof drains from the drain body to vertical downspout. Include all horizontal roof drain piping, which occurs above the finished floor ceiling line. Insulate entire roof drain hangers, up to threaded rod.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Flexible Elastomeric: 3/4 inch thick.
b. Polyolefin: 3/4 inch thick.

F. Condensate and Equipment Drain Water below 60 Deg F:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.

G. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.

3.20 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches: PVC, Color-Coded by System: 20 mils thick

D. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches: Aluminum, Smooth 0.024 inch thick.

A. Piping, Concealed: PVC, Color-Coded by System: 20 mils thick.

B. Piping, Exposed: Aluminum, Smooth 0.024 inch thick.

3.21 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch thick.

D. Piping, Exposed:
1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch thick.

3.22 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 22 07 00

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Specialty valves.
4. Flexible connectors.
5. Escutcheons.
6. Sleeves and sleeve seals.
7. Wall penetration systems.

1.3 SUBMITTALS

A. Product Data: For the following products:
1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Backflow preventers and vacuum breakers.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Water penetration systems.

B. Water Samples: Specified in "Cleaning" Article.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

A. 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 and Construction Manager no fewer than two (2) days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Architect's and Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 GENERAL

A. A complete system of hot and cold water supply to all plumbing fixtures and mechanical equipment shall be supplied and installed as shown on the Drawings. The water supply system shall be installed using the materials and methods as specified in the following paragraphs.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B88, Type K (ASTM B88M, Type A) water tube, annealed temper.

C. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. “Tube pull” or “Tee drill” fittings are NOT ALLOWED.

F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

G. Unions in first subparagraph below are available in NPS 1/4 to NPS 4.
   1. 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 STAINLESS-STEEL PIPING

A. Potable-water piping and components shall comply with NSF 61 Annex G.

B. Stainless-Steel Pipe: ASTM A312/A312M, Schedule 10.

C. Stainless-Steel Pipe Fittings: ASTM A815/A815M.

D. Appurtenances for Grooved-End, Stainless-Steel Pipe:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International.
      b. Apollo-Shurjoint Piping Products USA Inc.
      c. Grinnell Mechanical Products.
      d. Victaulic Company.
   2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.

2.4 DUCTILE-IRON PIPE AND FITTINGS (FOR UNDERGROUND USE)

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151 cement mortar lined ductile iron pipe, with mechanical-joint bell and plain spigot end.

B. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6 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.

2.7 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.
   1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
      a. Cascade Waterworks Manufacturing.
      b. Dresser, Inc.; Dresser Piping Specialties.
      c. Ford Meter Box Company, Inc. (The).
      d. JCM Industries.
      e. Romac Industries, Inc.
      f. Smith-Blair, Inc; a Sensus company.
      g. Viking Johnson; c/o Mueller Co.

2.8 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. Unions in first paragraph below are available in at least NPS 1/2 to NPS 2 (DN 15 to DN 50).

C. Dielectric Unions:
   1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. See Division 01 Section "Product Requirements."

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. EPCO Sales, Inc.
   d. Hart Industries International, Inc.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Wilkins Water Control Products.
3. Description:
   g. Pressure Rating: 150 psig at 180 deg F.
   h. End Connections: Solder-joint copper alloy and threaded ferrous.

D. Dielectric Flanges:
4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. EPCO Sales, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
5. Description:
   e. Factory-fabricated, bolted, companion-flange assembly.
   f. Pressure Rating: 150 psig.
   g. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

E. Dielectric-Flange Kits:
6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
7. Description:
   e. Non-conducting materials for field assembly of companion flanges.
   f. Pressure Rating: 150 psig.
   g. Gasket: Neoprene or phenolic.
   h. Bolt Sleeves: Phenolic or polyethylene.
   i. Washers: Phenolic with steel backing washers.

F. Dielectric Couplings:
8. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Calpico, Inc.
   b. Lochinvar Corporation.
9. Description:
   c. Galvanized-steel coupling.
   d. Pressure Rating: 300 psig at 225 deg F.
   e. End Connections: Female threaded.
   f. Lining: Inert and noncorrosive, thermoplastic.

G. Dielectric Nipples:
10. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Perfection Corporation; a subsidiary of American Meter Company.
    b. Precision Plumbing Products, Inc.
    c. Victaulic Company.

11. Description:
    d. Electroplated steel nipple complying with ASTM F 1545.
    e. Pressure Rating: 300 psig at 225 deg F.
    f. End Connections: Male threaded or grooved.
    g. Lining: Inert and noncorrosive, propylene.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. The VMC Group.
   2. Triplex.
   3. Mercer Rubber Co.
   4. Metraflex, Inc.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig.
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig.

D. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.

E. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.10 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. Split Casting, Cast Brass: Polished, chrome-plated or rough-brass finish with concealed hinge and setscrew.

C. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.11 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.12 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex, Inc.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.13 WALL PENETRATION SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. SIGMA.

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
   1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
   2. Housing: Ductile-iron casting with hub, water stop, anchor ring, and locking devices. Include gland, bolts, and nuts.
   3. Housing-to-Sleeve Gasket: EPDM rubber.
   4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
   5. Pipe Sleeve: ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Lead: It is forbidden that lead in any form be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then ALL of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and reinstalled using ALL NEW MATERIALS.

B. 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.

C. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. No bushing of any nature shall be allowed in piping.

D. All exposed chrome plated, polished or enameled connections from fixtures shall be put up with special care, showing no tool marks or threads at fittings, and supported by neat racks or hangers with round head screws of same material and finish.

E. Wade Shok-stop, or approved equal, sealed air chambers shall be provided in all water branches to fixtures, sized in accordance with manufacturer's recommendations, concealed, accessible, and located so as to protect each group of plumbing fixtures.

F. The fabrication of copper pipe and fittings shall in every detail conform to the recommendations and instructions of the fitting manufacturer. The tools used shall be the tools adapted to that specific purpose.

G. No underground domestic water piping shall be permitted below the building.

H. No underground domestic water piping shall be permitted below the building. Looped piping or underfloor shall be Type K copper with no joints (for trap primers and island case work only).

I. All buried piping shall be buried a minimum of 30" below finished grade including domestic water.

J. Water lines shall not be run under slab, except for main entry with proper sleeving.

K. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

L. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

M. Install underground ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.

N. Building Entrance:
   1. Water entry shall be within building Water entry outside of building with a wall penetration above grade is not acceptable.
   2. A metallic sleeve shall be inserted in the forms of the building wall through which the water service enters the building. The interior diameter of such sleeve shall be four inches (4") greater than the exterior diameter of the water service.
   3. The water service pipe from within the building shall be extended to a point five (5) feet outside the building wall through this sleeve. The position of the water service in this sleeve shall be concentric and the intervening space shall be packed in a flexible manner to avert the flow of water from outside of the building into the basement.
   4. The interior pipe extended outside the building shall be provided with a protective wrapping of "Tape Coat" SP warmed with hand torch. This protective tape shall be applied with "half lap" coverage in strict accordance with the manufacturer's published instructions. The cast iron pipe connected to the pipe extending from the building wall shall contain two (2) caulked joints within four feet of the union of the cast iron pipe and the interior pipe from the building.

O. Connections of dissimilar metal piping shall be made using dielectric fittings.

P. Install domestic water piping level and plumb.

Q. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

R. 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.

S. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

T. Install piping adjacent to equipment and specialties to allow service and maintenance.

U. Install piping to permit valve servicing.

V. 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. All-thread

pipe nipples are not allowed in any piping system. Threaded nipples less than 1/2" in diameter shall be Schedule 80.

W. Install piping free of sags and bends.

X. Install fittings for changes in direction and branch connections.

Y. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Z. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

AA. Install thermostats in hot-water circulation piping. Comply with requirements of the International Energy Conservation Code.

BB. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

CC. Irrigation Provisions: Furnish and install capped and/or valved water lines under paving, through retaining walls in paved plaza areas and as indicated on Drawings for connections and extensions under work of Section Irrigation (Sprinkler) System.

3.3 TESTING AND STERILIZATION

A. All water piping systems shall be properly tested to assure their being absolutely leaktight. In the case of pipes which are to be insulated, these tests shall be completed and the piping system proven to be absolutely tight before any insulation is applied. Wherever pipes are placed so that they will ultimately be concealed, these tests shall be conducted and the absolute tightness of each piping system shall be demonstrated before the system is concealed.

B. The procedure of these tests shall consist of subjecting a piping system to a hydrostatic pressure per Section 23 05 00. During the test period, all pipe, fittings and accessories in the particular piping system which is being tested shall be carefully inspected. If leaks are detected, such leaks shall be stopped by means designated by the Owner's duly authorized representative and the hydrostatic test shall again be applied. This procedure shall be repeated until, for an entire twenty-four hour period, no leaks can be found while the system being tested is subjected to the pressure mentioned above.

C. Wherever conditions permit, each piping system shall thereafter be subjected to its normal operating pressure and temperature for a period of no less than five (5) days. During that period, it shall be kept under the most careful observation. The piping systems must demonstrate the propriety of their installation by remaining absolutely leaktight during this period. Even though the completion of these tests is satisfactory, there is a continuing responsibility for the ultimate, proper, and satisfactory operation of such piping systems and their accessories.

D. After completion of the testing, the entire cold and hot water piping systems, with attached equipment, shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine. The chlorinating materials shall be either liquid chlorine conforming to U. S. Army Specification No. 4-1 or calcium hypochlorite or chlorinated lime conforming to the requirements of Federal Specification O-C-114. The sterilizing solution shall be allowed to remain in the system for a period of eight (8) hours during which time all valves and faucets shall be opened and closed several times. After sterilization, the solution shall be flushed from

the system with clean water until the residual chlorine content is not greater than 0.2 parts per million.

E. The sterilization process shall be conducted as required by the Health Department of the City of Stafford, Texas and the Specifications above, and upon completion of the process, the Health Department shall test and certify the cleanliness of the water piping system. The Plumbing Subcontractor shall pay all costs and charges incidental to this test and certification.

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

A. Steel-Piping Grooved Joints: Roll groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE INSTALLATION

A. Install shutoff valve accessible from floor, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Provide shut-off valve for each battery of fixtures located above ceiling near each bathroom.

A. NPS 1/2 or NPS 3/4 (DN 15 or DN 20) inlet hose-end drain valves may be adequate for application in first paragraph below.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
   1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
   2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

B. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

C. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.Install shutoff valve immediately upstream of each dielectric fitting.

D. Valve Boxes:
   1. For each underground valve installed by the Contractor, the Contractor shall provide and install a two piece, screw adjustable type valve box. These valve boxes shall be designed for heavy roadway service and they shall have a deep socket type of cover which prevents their being accidentally knocked out of position.
   2. The word "WATER" shall appear on each cover. The installation of these members shall be such that by the use of the adjustable screw type bodies the tops are just flush with the finished grade. These valve boxes shall be Tyler Pipe Industries #6850, or approved equal.

3.6 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

A. Support vertical piping and tubing at base and at each floor.

B. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

C. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.

D. Install supports for vertical copper tubing every 10 feet.

3.8 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 for plumbing fixture 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.

3.9 PAINTING

A. All exposed piping interior and exterior shall be painted. Interior color shall be according to the adopted color codes and shall be appropriately labeled at interviews in specified height letters.

B. Piping exposed to view shall be painted to comply to Owner approved color scheme.

C. Piping on roof or building exterior shall be painted with epoxy or polyurethane industrial coating.

3.10 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 1-1/2 times the working pressure or 150 psig, (whichever is higher) immediately prior to completion without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four (4) hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.
7. Stafford MSD Construction Services Division representative and Architect's/Engineer's representative shall monitor and approve all tests.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.12 ADJUSTING

A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.13 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow it 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 it 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:
   e. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   f. 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.

3.14 PIPING SCHEDULE

E. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

F. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

G. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
1. Soft copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
2. Pipe: All pipe used for underground water piping mains from the meter to the point of entry into the building shall be either:

H. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be the following:
1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.

I. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
1. Hard copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

J. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Hard copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.

K. Aboveground domestic water piping, NPS 5 to NPS 8 , shall be one of the following:
1. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
2. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

3.15 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
   2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
   3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
   4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 22 11 16

SECTION 22 13 16
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.
   2. Special pipe fittings.
   3. Encasement for underground metal piping.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

H. TPE: Thermoplastic elastomer.

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.

B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping;

"NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 PVC PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-SEWER" for plastic sewer piping.

B. Solid-Wall PVC Pipe: Schedule 40 PVC, conform to ASTM D1785 Soil and Waste Vent piping.

C. PVC Socket Fittings: ASTM D2665, made to ASTM D3311 drain, waste, and vent patterns to fit Schedule 40 with solvent-cemented joints.

D. Adhesive Primer: ASTM F656.

E. Solvent Cement: ASTM D2564.

1.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Service class.

B. Gaskets: ASTM C564, rubber.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
   1. Standard: ASTM C1277.
   1. Description: Two-piece ASTM A48/A48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564,, rubber sleeve with integral, center pipe stop.
   2. Couplings in subparagraph below are available in NPS 1-1/2 to NPS 15 (DN 40 to DN 375) and are economical, but may not be suitable for installation in corrosive soil.
   3. Coordinate subparagraph and list below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semi-proprietary specifications.
   4. Manufacturers:
      a. ANACO.
      b. Fernco, Inc.
      c. Ideal Div.; Stant Corp.
      d. Mission Rubber Co.
      e. Tyler Pipe; Soil Pipe Div.

2.4 SPECIAL PIPE FITTINGS

A. Transition Couplings:
   1. Manufacturers:
      a. Dallas Specialty & Mfg. Co.
      b. Fernco, Inc.
      c. Logan Clay Products Company (The).
      d. Mission Rubber Co.
      e. NDS, Inc.
      f. Plastic Oddities, Inc.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Non-pressure Transition Couplings:
      a. Standard: ASTM C1173.
      b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
      c. End Connections: Same size as and compatible with pipes to be joined.
   4. Sleeve Materials:
      a. For Cast-Iron Soil Pipes: ASTM C564, rubber.
      b. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
      c. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Non-pressure Transition Couplings:
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Mission Rubber Co.
   2. Standard: ASTM C1460.
   3. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   4. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless cast-iron soil pipe and fittings and CISPI hubless piping couplings; and coupled joints.

C. Aboveground soil and waste piping NPS 6 and larger shall be the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless cast-iron soil pipe and fittings and CISPI hubless piping couplings; and coupled joints.

D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless cast-iron soil pipe and fittings and CISPI hub-less piping couplings; and coupled joints.

E. Underground, soil, waste, and vent piping NPS 6 and smaller shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Solid-wall, Sewer and Drain Series, Schedule 40 PVC pipe; PVC socket fittings; and solvent-cemented joints. PVC pipe and fittings shall not be used in branch drain lines handling grease waste, hot water discharged from dishwashers, laundry equipment, water heater relief valves, etc.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Basic piping installation requirements are specified in Division 22.

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.

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. Cleanouts:
   1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
   2. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

K. 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."

L. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A674 or AWWA C105.

N. 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 two (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.

O. Underground piping shall be bedded in clean bank sand, select fill or cement stabilized sand.

P. 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 or drag in line and pull past each joint as completed.

Q. 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 2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
   2. Horizontal Sanitary Drainage Piping: 1 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

R. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

S. Install underground PVC soil and waste drainage piping according to ASTM D2321.

T. 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 hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

D. PVC Non-pressure Piping Joints: Join piping according to ASTM D2665.

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.
      b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer than 100 Feet, if indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

H. Install supports for vertical PVC piping every 48 inches.

I. 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 soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

B. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

C. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

D. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

E. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   3. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   4. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   5. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   6. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch W.G.. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   7. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   8. Prepare reports for tests and required corrective action.
   9. Isolate test source and allow to stand for four (4) hours. Leaks and loss in test pressure constitute defects that must be repaired.
   10. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   11. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two (2) coats of water-based UV resistant latex paint.

END OF SECTION 22 13 16

SECTION 22 20 00
NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. For service entrance contractor will coordinate with the gas company and pay all fees and permits required for a complete and operating gas service to the project.

B. This Section includes piping and related specialties for natural gas piping

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping specialties.
   2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   3. Pressure regulators. Include rated capacities and operating characteristics.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, and attachments of the same to building structure.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Pipe material.

C. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code – Steel”.

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX – “Welding and Brazing Qualifications”.

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 and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

C. Protect stored PE pipes and valves from direct sunlight.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 08 31 13 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.
   2. Service Regulators: 65 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, Schedule 40 black steel, AST M A53, Type E or S, Grade B.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      a. Material Group: 1.1.
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

B. Unless otherwise specifically required, all steel pipe provided for gas piping systems shall be provided with beveled ends and assembled with weld fittings on all pipe 2" and larger and all size piping installed within the ceiling plenum space. No pipe smaller than 3/4", shall be used. From the emergency shutoff valve to the outlets and exposed pipe less than 2" in size, the pipe shall be assembled with threaded malleable fittings provided all joints are exposed.

C. PE Pipe: ASTM D2513, SDR 11.
   1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
   2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
   3. Transition Service-Line Risers: Factory fabricated and leak tested.
      a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
      b. Outlet shall be threaded or flanged or suitable for welded connection.
      c. Bridging sleeve over mechanical coupling.
      d. Factory-connected anode.

e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
   a.
   b. PE body with molded-in, stainless-steel support ring.
   c. Buna-nitrile seals.
   d. Acetal collets.
   e. Electro-zinc-plated steel stiffener.
5. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a.
   b. Fiber-reinforced plastic body.
   c. PE body tube.
   d. Buna-nitrile seals.
   e. Acetal collets.
   f. Stainless-steel bolts, nuts, and washers.

2.3 PIPING SPECIALTIES

A. Flexible Pipe Connectors:
   1. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
      a. End Connections, NPS 1-1/2 and Smaller: Threaded steel pipe nipple.
      b. End Connections, NPS 2 and Larger: Flanged steel nipple.
      c. All-thread pipe nipples are not allowed.
      d. Threaded nipples less than 1/2" in diameter shall be Schedule 80.

B. Appliance Flexible Connectors:
   1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
   2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
   3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
   4. Corrugated stainless-steel tubing with polymer coating.
   5. Operating-Pressure Rating: 0.5 psig.
   6. End Fittings: Zinc-coated steel.
   7. Threaded Ends: Comply with ASME B1.20.1.
   8. Maximum Length: 72 inches

C. Quick-Disconnect Devices: Comply with ANSI Z21.41.
   1. Copper-alloy convenience outlet and matching plug connector.
   2. Nitrile seals.
   3. Hand operated with automatic shutoff when disconnected.
   4. For indoor or outdoor applications.
   5. Adjustable, retractable restraining cable.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg-F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.5 MANUAL VALVES

A. All valves shall be UL listed, AGA or CSA approved for natural gas service. Refer to specification section 22 05 23. Valves or cocks 2" and smaller shall be ball valves, flat or square head with threaded ends such as Balon series S ductile iron valves, or Owner-approved equal. Valves should come with locking device. Valves or cocks larger than 2" shall be ball valves, square head series with flange connections such as Balon series F ductile iron valves, or Owner-approved equal. Valves shall be furnished with locking device.

B. Gas Pressure Regulator bypass valves are not allowed.

C. On the inlet and discharge side of the meter and pressure regulators and at building entrance, install a wrench operated plug cock valve. The flanges of this stop valve shall be dimensioned, drilled, faced and spot faced to conform to the Class 125 American Standard for Cast Iron Flanges (B16.1 1948). Provide a pressure gage before the meter and after the PRV. Provide a line size tee and valve with plug on the building side of the PRV for an emergency gas feed.

2.6 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.
   1. Shut-off Valves shall be U.L. Listed F.M. Approved for natural gas service, 2-way electrically tripped solenoid type; fail safe closed; manual reset; Type 1 solenoid enclosure; NBR seals and disc; stainless steel core tube and springs; copper coil; manufactured by ASCO Red Hat Series 8044 or approved equal.

2.7 PRESSURE REGULATORS

A. General Requirements:
   1. Single stage and suitable for natural gas.
   2. Steel jacket and corrosion-resistant components.
   3. Elevation compensator.
   4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
   1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
   2. Springs: Zinc-plated steel; interchangeable.
   3. Diaphragm Plate: Zinc-plated steel.
   4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
   5. Orifice: Aluminum; interchangeable.
   6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
   7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
   8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
   9. Overpressure Protection Device: Factory mounted on pressure regulator.
   10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
   11. Maximum Inlet Pressure: 5 psig <Insert pressure>.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
   1. Body and Diaphragm Case: Die-cast aluminum.
   2. Springs: Zinc-plated steel; interchangeable.
   3. Diaphragm Plate: Zinc-plated steel.

4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure (unless otherwise indicated on the Drawings):
   a. Central Plant Equipment: 5 psig..
   b. Kitchen Equipment: 1 psig.

D. Acceptable Manufacturers:
1. American Meter Company.
2. Fisher Controls International.
3. Invensys Energy Metering.
4. National Meter.
5. Schlumberger Limited.

2.8 HEADERS

A. The gas distribution header installed by this Contractor in the building shall be fabricated of Schedule 40 black steel pipe. The pipe and welding materials for this header shall be carefully selected, and the welding operations shall be carefully supervised.

B. Welding nipples neatly aligned shall be provided for the outlets of the header. After the header has been completely fabricated, it shall be temporarily sealed and subjected to a pneumatic test pressure of 100 pounds per square inch. While the header is subjected to this pressure, all welded joints shall be given an application of soapy water for the purpose of detecting minute leaks which might not otherwise be observed. These leaks shall not be repaired by any peening operations. Such leaks shall be remedied by chipping and re-welding until the header is devoid of leaks at that pressure. The header shall then be subjected to a hydrostatic test pressure of 200 pounds per square inch. Under these circumstances, the test pressure of the water confined in the header shall not decrease in a four (4) hour period of observation. If leaks are encountered, they shall be repaired and re-tested until proven tight.

C. The header shall be provided with a one half inch (1/2") drain connection "taken off" the bottom of the header and terminated in a suitable stop cock. This one half inch (1/2") drain connection shall have its origin in a 2" x 1/2" welding reducer having its two inch (2") end so welded to the header as to completely drain that member. Each outgoing branch from the header shall be provided with a gas stop valve of gas cock. The nature of the outgoing welding nipples shall be such that these cocks shall be aligned in a neat horizontal line.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 PIPING INSTALLATION

A. Install fittings for changes in direction and branch connections.

B. Install pressure gage downstream from each service regulator. Pressure gages are specified in Section 23 05 19 "Meters and Gages for HVAC Piping."

C. Gas meter shall be located in mechanical court located directly outside the main mechanical room with a Rockwell plug type gas valve with grease fittings and handle or wrench provided for emergency gas shut off. Protect meter and piping with heavy pipe bollards.

D. Near the point at which each outgoing line leaves the gas header, the Contractor shall install a stop valve or cock. These wrench operated valves shall each be provided with an appropriate wrench. Cocks of the same type shall, moreover, be installed at each other point indicated on the Drawings.

E. Drip pipes shall be provided throughout the gas piping systems for the purpose of accumulating moisture and condensate. They shall be sized no smaller than the gas piping to which they are connected in each instance. These drip pipes shall be U shaped providing an effective water seal of no less than twelve inches (12") of water. The extremity of each U shaped drip pipe shall be threaded and capped with a suitably sized, screwed pattern, black, standard weight, and malleable iron cap.

F. All drip pipes shall be located in an accessible position so that the condensate may either be pumped from the system or so that a water seal shall be provided in the event that the water forming the seal evaporates.

G. The Contractor shall take thermal expansion under consideration during installation. The Contractor shall follow all requirements set by the manufacturer to protect the system from damage due to thermal expansion.

H. Branch runs shall be made off the top of main lines. Horizontal pipes shall pitch toward the appliance and shall terminate with dirt leg and line size valve. Connections to the appliances shall be hard pipe and approved UL connector

I. Gas pipe run within the building shall run in accordance with all applicable codes. Provide sleeves on interior pipe only as required by code.

J. Gas pipe run on the building roof shall be supported at appropriate interval to prevent sagging as indicated in Piping Support Section 22 05 19, on factory fabricated pillow block pipe stand manufactured by “MIRO INDUSTRIES” model 24-R or equal and approved (no wood supports). Support spacing shall be determined by the roof type and loading.

K. Gas piping on roof shall be clearly identified using all weather, mechanically secured labeling.

L. Contractor shall take all necessary precautions to prevent any damage to the roofing system due to pipe cutting, welding or installation of piping. Any damage shall be repaired by the roofing contractor, payment of that will be made by the responsible party. Extend and nature of the repairs necessary shall be as approved by Stafford MSD Construction Services Division.

M. All exposed piping shall be painted and labeled in accordance with Section 22 05 53 - “Identification for Plumbing Piping and Equipment”. Pipe installed on roof however, shall be painted with two (2) coats of Aluminum Industrial coating.

N. Provide lever handle gas valve to each piece of equipment and where indicated.

O. All gas lines entering building shall be valved on the exterior of the building above grade.

P. Pressure regulators shall be installed where required at the exterior of the building. At each regulator requires a test tee with nipple and cap downstream, and unions and gas cocks inlet side of regulator.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric unions in piping at connections of dissimilar metal piping and tubing.

3.5 UNDERGROUND GAS PIPING

A. Natural gas service run underground from the gas meter to the building shall be **MDPE - YELLOW POLYETHYLENE WITH SOCKET HEAT FUSION JOINTS** and fittings gas pipe and tubing shall be manufactured and tested to meet or exceed the national standards for gas pressure pipe and tubing including ASTM D2513 and the regulations in part 192 of the federal gas pipeline regulations. Furnish and install copper tracing and secure to piping where it exits grade and affix identification tag. Pipe shall be laid on 6" of wet compact bank sand at a minimum depth of 30" below grade and shall be sloped to prevent pockets. Provide a dirt leg at the lower end of each run. Backfill trench with wet compacted bank sand to 6" above pipe. The remainder of backfill shall be select backfill and shall meet all compaction requirements set forth by the general trenching and backfill requirements

B. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

C. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.
   1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

D. Install underground, PE, natural-gas piping according to ASTM D2774.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
   2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches of each fitting and coupling.

G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

H. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
   2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
   3. NPS 1-1/2: 12 feet with 3/8-inch rod.
   4. NPS 2: 13 feet with 3/8-inch rod.

I. Install supports for vertical, Schedule 40, steel piping every 15 feet.

3.7 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for natural gas piping, valves, and specialties. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Piping Leak Tests: The entire gas piping systems shall be subjected to a pneumatic test pressure of 100 pounds per square inch. Cap and fill natural gas piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 100 psig. Isolate test source and let stand for twenty-four (24) hours to equalize temperature. Refill system, if required, to test pressure; hold for eight (8) hours with no drop in pressure.

C. Repair leaks and retest until no leaks exist.

D. Test pressure regulators for proper operation.

E. Natural-gas piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.9 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following: PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.

B. Aboveground natural-gas piping shall be the following: Steel pipe with wrought-steel fittings and welded joints.

3.10 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Retain and revise applicable piping applications. Coordinate with materials specified in Part 2.

B. Aboveground, branch piping NPS 1 and smaller shall be the following: Steel pipe with malleable-iron fittings and threaded joints.

C. Aboveground, distribution piping shall be the following: Steel pipe with wrought-steel fittings and welded joints.

3.11 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following: Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following: Steel pipe with steel welding fittings and welded joints.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following: Two-piece, full-port, bronze ball valves with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following: Two-piece, full-port, bronze ball valves with bronze trim.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following: Two-piece, full-port, bronze ball valves with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following: Two-piece, full-port, bronze ball valves with bronze trim.

E. Valves in branch piping for single appliance shall be the following: One-piece, bronze ball valve with bronze trim.

END OF SECTION 22 20 00

SECTION 22 33 00
ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Commercial, electric, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

B. Product Certificates: For each type of commercial, electric, domestic-water heater.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.
   a. Commercial, Electric, Storage, Domestic-Water Heaters:
      1) Storage Tank: Five (5) years.
      2) Controls and Other Components: Three (3) years.
   b. Expansion Tanks: Five (5) years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. O. Smith Corporation.
      b. Rheem Manufacturing Company.
      c. State Industries.
      d. Bock.
   2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
   3. Standard: UL 1453.
   4. Storage-Tank Construction: Non-ASME-code, steel vertical arrangement.
      a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
         1) NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
         2) NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.
      b. Pressure Rating: [**150 psig**].
      c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
   5. Factory-Installed, Storage-Tank Appurtenances:
      a. Anode Rod: Replaceable magnesium.
      b. Drain Valve: Corrosion-resistant metal with hose-end connection.
      c. Insulation: Comply with ASHRAE/IES 90.1.
      d. Jacket: Steel with enameled finish or high-impact composite material.
      e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three (3).
      f. Temperature Control: Adjustable thermostat.

g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

6. Special Requirements: NSF 5 construction.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. A. O. Smith Corporation.
   b. AMTROL, Inc.
   c. State Industries.
   d. TACO Comfort Solutions, Inc.
2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
4. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.
5. Capacity and Characteristics:
   a. Working-Pressure Rating: [**100 psig**] [**150 psig**] <Insert value>.
   b. Capacity Acceptable: [**2 gal.**] [**4 gal.**] [**7 gal.**] [**10 gal.**] <Insert value> minimum.
   c. Air Precharge Pressure: <**Insert system pressure**>.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

D. Heat-Trap Fittings: ASHRAE/IES 90.1.

E. Manifold Kits: Domestic-water-heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and [**calibrated**] [**memory-stop**] balancing valves to provide balanced flow through each domestic-water heater.
1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."

F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- maximum outlet pressure unless otherwise indicated.

G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of [**18 inches**] <**Insert dimension**> above the floor.

L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
   1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
   2. Maintain manufacturer's recommended clearances.
   3. Arrange units so controls and devices that require servicing are accessible.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   7. Install anchor bolts to elevations required for proper attachment to supported equipment.
   8. Anchor domestic-water heaters to substrate.

B. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-

valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

C. Install [**combination temperature-and-**]pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

E. Install thermometers on inlet and outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

F. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

G. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of [**25 psig**] <**Insert value**>. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."

H. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

I. Fill electric, domestic-water heaters with water.

J. Charge domestic-water expansion tanks with air to required system pressure.

K. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training shall be a minimum of one hour(s).

END OF SECTION 22 33 00

SECTION 22 40 00
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.

B. Coordinate with Commissioning Requirements indicated in Section 019100. This contractor is responsible to comply with all requirements for the above section.

1.2 SUMMARY

C. This Section includes the following conventional plumbing fixtures and related components:
1. Faucets for lavatories, showers and sinks.
2. Laminar-flow faucet-spout outlets.
3. Flushometers.
4. Toilet seats.
5. Protective shielding guards.
6. Fixture supports.
7. Water closets.
8. Urinals.
9. Lavatories.
10. Kitchen sinks.
11. Service sinks.
12. Owner-furnished fixtures.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

A. Product Data: For each type of 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.

A. Shop Drawings: Diagram power, signal, and control wiring.

B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

B. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one (1) source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Regulatory Requirements:
   1. Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
   2. Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
   3. International Plumbing Code, 2015 edition with City of Stafford, Texas amendments.
   4. Texas Accessibility Standards (TAS) - Elimination of Architectural Barriers, Texas Government Code, Chapter 469 administered by the Texas Department of Licensing and Regulation (TDLR), effective March 15, 2012.

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. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

1.4 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.
   1. Failures include, but are not limited to, the following:
      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.

1.4 MAINTENANCE

A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets: Lavatory faucets shall be metered, push type.
   1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
      a. Chicago.
      b. Delta
      c. Symmons.

B. Lavatory faucet supplies: 3/8" chrome plated copper attached to a 1/2" IPS x 3/8" flare chrome plated loose-key stop. All exposed chrome plated fittings polished.

2.2 SINK FAUCETS

A. 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. Elkay, Inc.
   2. Chicago Faucets.
   3. Moen, Inc.
   4. Just Manufacturing Company.
   5. Kohler Co.

B. Description: Refer to Plumbing Fixture Schedule on the Drawings..

2.3 FLUSHOMETERS

A. 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. Sloan Valve Company
   2. Toto.

B. Description: Refer to Plumbing Fixture Schedule on the Drawings.

2.4 TOILET SEATS

A. 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. Bemis Manufacturing Company.
   2. Benke.

B. Description: Refer to Plumbing Fixture Schedule on the Drawings.

2.5 FIXTURE SUPPORTS

A. 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. Josam Company.

2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water-Closet Supports:
1. Description: Combination carrier designed for accessible standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:
1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture II, urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:
1. All wall hung lavatories shall have carriers.
2. Description:
a. Type I, lavatory carrier with exposed arms and tie rods
b. Type II, lavatory carrier with concealed arms and tie rod
c. Type III, lavatory carrier with hanger plate and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
3. Accessible-Fixture Support: Include rectangular steel uprights.

E. Sink Supports:
1. All wall hung sinks shall have carriers.
2. Description: Type I, sink carrier with exposed arms and tie rods II, sink carrier with hanger plate, bearing studs, and tie rod III, sink carrier with hanger plate and exposed arms for sink-type fixture. Include steel uprights with feet.

2.6 WATER CLOSETS

A. 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. American Standard Companies, Inc.
2. Kohler Co.
3. Toto.

B. Description: Refer to Plumbing Fixture Schedule on the Drawing.

2.7 URINALS

A. 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. American Standard Companies, Inc.
2. Kohler Co.
3. Toto

B. Description: Wall hung vitreous china, siphon jet type, flush valve actuated with Sloan-Royal / Regal manually operated flush valve only with vacuum breaker and screwdriver stop, piped to

the right-hand side, according to National Plumbing Code. (All wall hung fixtures shall have chair carriers)..

1. Type: Blowout Siphon jet Blowout with extended shields Siphon jet with extended shields Washout with extended shields.
2. Strainer or Trap way: Integral cast strainer Separate removable strainer Open trap way with integral trap.
3. Design Consumption: 0.5gal. /flush.
4. Color: White.

2.8 LAVATORIES

A. 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. American Standard Companies, Inc.
2.
3. Kohler Co.
4. Toto

B. Description: Refer to Plumbing Fixture Schedule on the Drawing.

2.9 COMMERCIAL SINKS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
1. Elkay Manufacturing Co.
2. Just Manufacturing Company.
3. Moen

B. Description: Refer to Plumbing Fixture Schedule on the Drawing.

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.
1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. 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.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. 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.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. 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.

P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

Q. 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.

R. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

T. 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."

U. 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.

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.

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.

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.

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 22 40 00

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23 05 00
COMMON WORK RESULTS IN HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Coordinate with Commissioning Requirements indicated in Section 019113. This Contractor is responsible to comply with all requirements for the above 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. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. HVAC demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

G. 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: Include Products specified in the following Sections:
1. Section 23 05 13 – Motors
2. Section 23 05 16 – Expansion Compensation
3. Section 23 05 19 – Meters & and Gauges
4. Section 23 05 23 – Valves
5. Section 23 05 39 – Sleeves, Flashings, Supports and Anchors
6. Section 23 05 48 – Vibration Isolation and Wind Controls for HVAC Piping and Equipment
7. Section 23 05 53 – Mechanical Identification
8. Section 23 05 93 – Testing, Adjusting and balancing
9. Section 23 07 13 – HVAC Insulation
10. Section 23 08 00 – Commissioning of HVAC
11. Section 23 09 23 – Energy Management and Control Systems
12. Section 23 23 00 – Refrigerant Piping and Specialties
13. Section 23 31 13 – Metal Ducts
14. Section 23 33 00 – Ductwork Accessories
15. Section 23 34 16 – Fans
16. Section 23 36 00 – Air Terminal Units
17. Section 23 37 00 – Air Inlets and Outlets
18. Section 23 41 00 – Filters
19. Section 23 48 00 – Sound Attenuators
20. Section 23 81 33 – Unitary Split–System Air–Conditioners
21. Section 23 74 16.13 – Packaged, Large-Capacity, Rooftop Air-Conditioning Units

B. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

C. Mark dimensions and values in units to match those specified.

D. Submit Fabrication Drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these Specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication Drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

E. All required Fabrication Drawings, except as noted otherwise, shall be prepared at a scale of not less than 1/4" = 1'-0". Fabrication Drawings for ductwork, air handling units, and sections in Mechanical Rooms shall be drawn at a minimum scale of 3/8" = 1'-0". Submit three blueline prints of each Fabrication Drawing to the Architect/Engineer for review. Reproduction and submittal of the Construction Documents is not acceptable. The Architect/Engineer will review the drawing and return one print with comments.

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 HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. All equipment and materials shall be new, unused and of United States Domestic manufacture.

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 HVAC 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 HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Prepare Coordination / Installation Shop drawings to a scale of 1/4"=1'0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
1. Structural floor, wall and roof opening sizes and details
2. Clearances for installing and maintaining insulation.
3. Locations of light fixtures and sprinkler heads.
4. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
5. Equipment connections and support details.
6. Exterior wall and foundation penetrations.
7. Routing of piping and ductwork.
8. Fire rated wall and floor penetrations.
9. Sizes and location of required concrete pads and bases.

1.8 APPLICABLE CODES AND STANDARDS

A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.

B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.

C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements of the following nationally accepted codes and standards:
   1. Underwriters' Laboratories, Inc., UL.
   2. Air Moving & Conditioning Association, AMCA.
   3. American Standards Association, ASA.
   4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE.
   5. American Society of Mechanical Engineers, ASME.
   6. American Society of Testing Materials, ASTM.
   7. American Water Works Association, AWWA.
   8. International Energy Conservation, Mechanical and Fuel Gas Codes, 2015 edition with City of Stafford, Texas amendments.
   9. National Bureau of Standards, NBS.
   10. National Fire Protection Association, NFPA.
      a. NFPA 70, National Electrical Code, 2017 edition with City of Stafford, Texas amendments.
   11. Sheet Metal & Air Conditioning Contractors' National Association, SMACNA.
   12. 2012 Texas Accessibility Standards, effective March 15, 2012.

D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.

E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.

1.9 DRAWINGS & SPECIFICATIONS

A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.

B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least 7 working days prior to bid opening date for issuance of an addendum.

C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.

D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.

E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution by made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 days prior to the bid date without fail.

F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.

G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.

H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) and Plumbing Design Documents and all other trades.

I. Coordinate with Division 01 requirements for substitution, unless noted otherwise the Contractors wishing to substitute products, materials or methods from those indicated or specified, shall submit such requests to the Owner or Engineer in writing and within THIRTY (30) WORKING DAYS OF NOTIFICATION OF CONTRACT AWARD. Requests for permission to utilize alternates or substitutions will not be considered after that time, unless the Specified item is unavailable or will adversely affect the completion of the Project. Claims submitted for consideration will require notarized letters from all parties involved and will be considered only if the Contractor has been timely in his delivery for review of all required equipment and material submittals. Owner or Engineer will investigate such requests for substitution and if acceptable will issue a letter allowing the substitution.

J. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.

K. Requests shall be bound and shall consist of three (3) sets of descriptive literature and performance data covering each item of equipment or material. The submittal shall include the following:
   1. Manufacturer’s name and phone number
   2. Name of the person submitting the product
   3. Model number
   4. Performance
   5. Statement of compliance with specification.
   6. Name of the individuals or company originating the submittal.

7. Name of the project for which the submittal is made.
8. An index page of the items submitted.
9. A written list of variations between the specified product and the submitted product.
10. Sufficient information, including scaled drawing of area and equipment involved at a scale of 1/4" = 1'-0" minimum, as required to demonstrate that the alternate or substituted product will fit in the space available.
11. Identification of each item of material or equipment matching that indicated on the Drawings. All applicable industry or national Listings, Labels, Approvals and Standards shall be clearly indicated.
12. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements shall be so indicated. All non-applicable information shall be crossed out.
13. Provide upon request of the Owner or Engineer, samples of materials and/or equipment as may be required.

L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions. The Engineer shall be the sole authority to approve or disapprove any and all substitutions.

M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

1.10 RECORD DOCUMENTS

A. Prepare Record Documents in accordance with the requirements in Special Project Requirements, in addition to the requirements specified in Division 23, indicate the following installed conditions.
1. Duct mains and branches, size and location, for both exterior and interior; locations of dampers, fire dampers, duct access panels, and other control devices; filters, fuel fired heaters, fan coils, condensing units, and roof-top A/C units requiring periodic maintenance or repair.
2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
5. Contract Modifications, actual equipment and materials installed.

B. The Contractor shall maintain a set of clearly marked black line record "AS-BUILT" prints on the job site on which he shall mark all work details, alterations to meet site conditions and changes made by "Change Order" notices. These shall be kept available for inspection by the Owner, Architect or Engineer at all times.

C. Contractor Startup and Commissioning Verification - the system will provide a secure page for each integrated system allowing the contractor responsible for each phase to sign on and certify the status of each piece of equipment.

D. Refer to Division 01 for additional requirements concerning record drawings. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Delivery of as built prints and re-producible is a condition of final acceptance.

E. The record prints shall be updated on a daily basis and shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall include at least two dimensions to permanent structure points.

F. At the Engineer's option, the Contractor shall transfer all data from the record "AS-BUILT" prints to an electronic media such as AutoCAD latest release, in order to plot the reproducible media "AS-BUILT" drawings. Since data stored on electronic media can deteriorate undetected or be modified without the Engineer's knowledge, the AutoCAD electronic drawing files are provided without warranty or obligation on the part of the Engineer as to accuracy or information contained in the files. All information in the files shall be independently verified by the user. Any user shall agree to indemnify and hold the Engineer harmless from any and all claims, damages, losses, and expenses including but not limited to Attorney's fees arising out of the use of the AutoCAD drawing files. Engineer shall furnish to the Contractor electronic media files of Contract Documents for the Contractor to use for inputting of the data from the record "AS-BUILT" prints and the Contractor shall return the revised electronic files on CD ROM properly labeled to the Engineer and shall submit the plotted reproducible drawings and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet as described in paragraph G. below.

G. Contractor shall transfer all marks from record drawings and submit a set of clear concise set of reproducible record "AS-BUILT" drawings and shall submit the reproducible drawings with corrections made by a competent draftsman and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineer’s Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet.

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 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 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 23 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. 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 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one (1) end with threaded brass insert, and one (1) solvent-cement-joint end.
   1. Manufacturers:
      a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Thompson Plastics, Inc.

C. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO INC.
      b. NIBCO, Inc.; Chemtrol Div.

2.5 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.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.

c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
1. Manufacturers:
a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. 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. Manufacturers:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
1. Manufacturers:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
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: Plastic Carbon steel Stainless steel. Include two (2) 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 (1) for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A53, 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.

E. Underdeck Clamp: Clamping ring with set screws.

F. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

G. PVC Pipe: ASTM D1785, Schedule 40.

H. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 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.

D. Finish: Polished chrome-plated.

E. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

F. Finish: Polished chrome-plated.

G. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

H. Split-Plate, Stamped-Steel Type: With concealed set screw or spring clips, and chrome-plated finish.

I. One-Piece, Floor-Plate Type: Cast-iron floor plate.

J. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT & FOUNDATION

A. Description: ASTM C1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

B. Foundations and pads shall be constructed of reinforced concrete and shall be sized and reinforced as noted or detailed on the Drawings. As a minimum, pads shall be 6" thick, by width and length as required by item it is under, reinforced with 6 x 6 W2.9 x W2.9 Welded Wire mesh.

C. Support attachments, unless otherwise noted on shown, shall be securely attached to the item's foundation, pad or building structure, per manufacturers recommendations and shall be approved by the Architect.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 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.

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. Insulated Piping: One-piece, stamped-steel type with spring clips.
      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 or split-casting, cast-brass type with polished chrome-plated finish.

g. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
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 with concealed or exposed-rivet hinge and set screw or spring clips.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. 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.
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.
d. 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 firestop 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.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 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 B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. 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.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. 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 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. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 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 HVAC 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.

E. Coordinate setting of equipment with the requirements of other trades so as to avoid conflicts and to insure compatibility. Equipment shall not block access for installation of other equipment.

F. Set base mounted equipment on permanent and finished supports. Temporary support, if any, shall be removed prior to making final pipe, duct, or electrical connections to equipment.

G. Adjust suspended equipment to final elevation prior to making pipe, duct or electrical connections.

H. Exercise caution during equipment placing operations to ensure that structure is not overloaded.

I. Do not move heavy equipment across floor or roof of insufficient load bearing capacity to support such equipment. Provide bracing or shoring as required, or use crane to place equipment directly on permanent and finished support.

J. All exterior mechanical appliances and equipment that are exposed to wind, including package units, condensing units, fans, equipment casings, rooftop units, hold-downs, curbs, etc., (whether integral or loose), shall be designed and installed to resist wind pressures in accordance with the IBC wind load zone designated for the project. Provide calculations signed and sealed by a Texas licensed professional engineer establishing wind velocity pressure values for the specific project in accordance with ASCE-7 adopted by the IBC applicable to the project.
   1. Ultimate Wind Speed: 147 mph, 3-second gust.
   2. Exposure: B.
   3. Risk Category: III.

3.5 PAINTING

A. Painting of HVAC 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.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
   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 Miscellaneous Cast-in-Place Concrete."

3.7 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 HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC 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.

3.9 GROUTING

A. Mix and install grout for HVAC 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 23 05 00

23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.

B. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

1.2 SCOPE

A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for Owner's use.

1.3 WORK SPECIFIED ELSEWHERE

A. Painting

B. Automatic temperature controls.

C. Power control wiring to motors and equipment.

1.4 REFERENCES

A. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

C. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.

D. ANSI/NEMA MG 1 – Motors and Generators.

E. ANSI/NEMA MG 2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors.

F. ANSI/NFPA 70 – National Electrical Code, 2017 Edition.

G. ANSI/UL 674 – Electric Motors and Generators for Use in Hazardous (Classified) Locations.

H. ANSI/UL 1004 – Electric Motors.

I. EISA - The Energy Independence & Securities Act 2007.

J. IECC – International Energy Conservation Code, 2015 edition with City of Stafford, Texas amendments.

K. IMC – International Mechanical Code, 2015 edition with City of Stafford, Texas amendments.

1.5 WARRANTY

A. Warrant the Work specified herein for one (1) year and motors for five (5) years beginning on data of Substantial Completion against becoming unserviceable or causing an objectionable appearance resulting from either defective or non-conforming materials or workmanship.

1.6 QUALITY ASSURANCE

A. Motors associated with variable frequency drives (VFD) shall be inverter-duty rated, and provided with grounded shaft or ceramic bearings to insulate shaft, and Class F 105 degrees C rise insulation. Ref. NEMA MG1 Part 31.

1.7 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 05 00.

B. Shop Drawings: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Product Data: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures variations, and accessories.

D. Motor Nameplate Information: Manufacturer's name, address, utility and operating data. Bandwidth: submit bandwidth requirements for all Ethernet connections to the Local Network.

E. Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.

F. Submit manufacturer’s installation instructions under provisions of Section 23 05 00. Indicate setting, mechanical connections, lubrication, and wiring instructions.

G. Refer to Division 01 for additional requirements.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 05 00.

B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three (3) years’ documented product development, testing, and manufacturing experience.

1.10 REGULATORY REQUIREMENTS

A. Conform to the National Electrical Code.

1.11 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver products to site under provisions of Section 23 05 00. Deliver clearly labeled, undamaged materials in the manufacturers' unopened containers.

B. Time and Coordination: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.

C. Storage:
1. Store and protect products under provisions of Section 23 05 00.
2. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof coverings. For extended outdoor storage, remove motors from equipment and store separately.

1.12 MAINTENANCE

A. Provide twelve (12) months maintenance of all materials and equipment under this Section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Electrical Service: Refer to Drawing schedules for required electrical characteristics.

C. Approved Manufacturers: Provide motors by a single manufacturer as much as possible.
1. Baldor-Reliance.
2. General Electric ES Energy Saver®.
3. Siemens.
4. Marathon® manufactured by Regal-Beloit America, Inc.
5. U.S. Electrical – NEMA Premium Efficiency.

D. Motor Characteristics
1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

E. General: Comply with NEMA MG 1 unless otherwise indicated.

F. Temperature Rise: Match insulation rating.

G. Starting Capability: As required for service indicated five (5) starts minimum per hour.

H. Phases and Current: Verify electrical service compatibility with motors to be used.
1. Up to 1/2 hp: Provide permanent split, capacitor-start single phase with inherent overload protection.
2. 3/4 hp and larger: Provide NEMA MG 1, Design B, squirrel-cage induction polyphase.
3. Provide two (2) separate windings on 2-speed polyphase motors.
4. Name plate voltage shall be the same as the circuit's normal voltage, serving the motor.

I. Service Factor: 1.15 for polyphase; 1.35 for single phase.

J. Starting Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Frames: U-frames 1.5 hp and larger.

L. Bearings: Provide sealed regreasable, shielded, anti-friction ball bearings; with top mounted Alemite lubrication fittings and bottom side drains minimum average life 100,000 hours typically, and others as follows:
   1. Design for radial and thrust loading where applicable.
   2. Permanently Sealed: Where not accessible for greasing.
   3. Sleeve-Type with Oil Cups: Light duty fractional horsepower motors or polyphase requiring minimum noise level.

M. Enclosure Type: Provide enclosures as follows:
   1. Concealed Indoor: Open drip proof (ODP).
   2. Exposed Indoor: Guarded.
   3. Outdoor Typical: Type II, TEFC.
   4. Outdoor Weather Protected: Type II, TEFC.

N. Overload Protection: Built-in sensing device for stopping motor in all phase legs and signaling where indicated for fractional horse power motors.

O. Noise Rating: "Quiet" except where otherwise indicated.

P. Efficiency: Provide premium efficient motors as defined in NEMA MG 1 in accordance with minimum full load efficiency listed in the following table, when tested in accordance with IEEE Test Procedure 112A, Method B, including stray load loss measure.

Q. Thermal Protection:
   1. Polyphase Motors: Comply with NEMA MG 1 requirements for thermally protected motors.
   2. Single Phase Motors: 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.

R. Additional Requirements for Polyphase Motors
   1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
   2. Motors Used with Variable-Frequency Controllers:
      a. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
      b. 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.
      c. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
      d. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

2.2 MOTOR EFFICIENCIES – NOMINAL, FULL LOAD, THREE PHASE

	Open Drip-Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
Motor HP	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	80.0	82.5	85.5	78.5
1.5	86.5	86.5	85.5	87.5	86.5	85.5
2	87.5	86.5	86.5	88.5	86.5	86.5
3	89.5	89.5	86.5	89.5	89.5	88.5
5	89.5	89.5	89.5	89.5	89.5	89.5
7.5	91.7	91.0	89.5	91.7	91.7	91.0
10	91.7	91.7	90.2	91.7	91.7	91.7
15	92.4	93.0	91.0	92.4	92.4	91.7
20	92.4	93.0	92.4	92.4	93.0	92.4
25	93.0	93.6	93.0	93.0	93.6	93.0
30	93.6	94.1	93.0	93.6	93.6	93.0
40	94.1	94.1	93.6	94.1	94.1	93.6
50	94.1	94.5	93.6	94.1	94.5	94.1
60	95.0	95.0	94.1	94.5	95.0	94.1
75	95.0	95.0	94.5	95.0	95.4	94.5
100	95.0	95.4	94.5	95.4	95.4	94.5
125	95.4	95.4	95.0	95.4	95.4	95.0
150	95.8	95.8	95.4	95.8	95.8	95.4
200	95.4	95.8	95.4	95.8	96.2	95.8

2.3 NEMA OPEN MOTOR SERVICE FACTORS

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5 - 150	1.15	1.15	1.15	1.15

2.4 MOTOR CONTROLLERS (STARTERS)

A. All motor controllers (for equipment furnished under Division 23) shall be furnished under Division 26 and installed under Division 26 unless otherwise noted on the plans.

B. Motor starters shall be furnished as follows.
   1. General: Motor starters shall be Schneider-Electric Class 8536 across-the-line magnetic type, full-voltage, non-reversing (FVNR) starter. All starters shall be constructed and

tested in accordance with the latest NEMA standards, sizes and horsepower. IEC sizes are not acceptable. Starters shall be mounted in a general purpose dead front, painted steel enclosure and surface-mounted. Provide size and number of poles as shown and required by equipment served. Provide a two speed, two winding or two speed, single winding motor starter as required for two speed motors.

2. Contacts: Magnetic starters' contacts shall be double break solid silver alloy.
3. All contacts shall be replaceable without removing power wiring or removing starter from panel. The starter shall have straight-through wiring.
4. Operating Coils: Operating coils shall be 120 volts and shall be of molded construction. When the coil fails, the starter shall open and shall not lock in the closed position.
5. Overload Relays: Provide manual reset, trip-free Class 20 overload relays in each phase conductor in of all starters. Overload relays shall be melting alloy type with visual trip indication. All 3 phase and single phase starters shall have one overload relay in each underground conductor. Relay shall not be field adjustable from manual to automatic reset. Provide 6 overload relays for two speed motor starters.
6. Pilot Lights: Provide a red running pilot light for all motor starters. Pilot lights shall be mounted in the starter enclosure cover. Pilot lights shall be operated from an interlock on the motor starter and shall not be wired across the operating coil.
7. Controls: Provide starters with HAND-OFF-AUTOMATIC switches. Coordinate additional motor starter controls with the requirements of Division 23. Motor starter controls shall be mounted in the starter enclosure cover.
8. Control Power Transformer: Provide a single-phase 480 volt control power transformer with each starter for 120 volt control power. Connect the primary side to the line side of the motor starter. The primary side shall be protected by a fuse for each conductor. The secondary side shall have one (1) leg fused and one (1) leg grounded. Arrange transformer terminals so that wiring to terminals will not be located above the transformer.
9. Auxiliary Contacts: Each starter shall have one (1) normally open and one (1) normally closed convertible auxiliary contact in addition to the number of contacts required for the "holding interlock", remote monitoring, and control wiring. In addition, it shall be possible to field-install three more additional auxiliary contacts without removing existing wiring or removing the starter from its enclosure.
10. Unit Wiring: Unit shall be completely pre-wired to terminals to eliminate any interior field wiring except for line and load power wiring and HVAC control wiring.
11. Enclosures: All motor starter enclosures shall be NEMA 1, general purpose enclosures or NEMA 3R if mounted exposed to high moisture conditions. Provide NEMA 4X when located near cooling towers.
12. Power Monitor: Provide a Macromatic PMPU phase failure and under-voltage relay, base and wiring required for starters serving motors 10 horsepower and larger. Set the under-voltage setting according to minimum voltage required for the motor to operate within its range.

C. Approved Manufacturers: Controller numbers are based on first named manufacturer. Provide one of the following manufacturers:
   1. ABB
   2. Danfoss
   3. Yaskawa

2.5 COMBINATION MOTOR STARTERS

A. General: Combination motor starters shall consist of a magnetic starter and a fusible or non-fusible disconnect switch in a dead front, painted steel NEMA 1 enclosure unless otherwise noted and shall be surface-mounted. Size and number of poles shall as shown and required by

equipment served. Combination motor starters shall be as specified for motor starters in Paragraph 2.4.B, except as modified herein.

B. Disconnect Switch: Disconnect switches shall be as specified in Division 26.

C. Approved Manufacturers: Controller numbers are based on first named manufacturer. Provide one of the following manufacturers:
   1. Siemens.
   2. Schneider Electric.
   3. ABB.

2.6 VARIABLE FREQUENCY DRIVES

A. Manufacturers
   1. General:
      a. All products provided under this section shall either be Pre-certified or certified prior to bid as described below. If for any reason the product listed is not appropriate to fully meet the project requirements, alternate products shall be certified and bid as described below.
      b. Acceptable Manufacturers
         1) ABB
         2) Danfoss
         3) Yaskawa
   2. Additional Product Certification: In the event that additional or alternate products from the listed Manufacturer of the Pre-Certified product line listed above are needed to accomplish the requirements of this project, additional products and applications shall be certified following the procedures and requirements of the certification specifications.
      a. Any product that is not certified will not be accepted.
      b. Upon satisfactory completion of the certification, a registration number will be issued for each product.
      c. Include the registration number for each product in the submittal
      d. The Owner reserves the right to accept or reject any products at their sole discretion as deemed in their best interest.

B. Where shown on the Drawings, adjustable frequency drives shall have the following features:
   1. The VFD shall be rated for 480 VAC (optional input voltages of 208-240 VAC). The VFD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on 40°C ambient and 5 kHz switching frequency continuous and utilize dynamic noise control for motors.
   2. The VFDs shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source VFDs are not acceptable. Insulated Gate Bipolar Transistors (IGBTs) shall be used in the inverter section. Bipolar Junction Transistors, GTOs or SCRs are not acceptable. The VFDs shall run at the above listed switching frequencies.
   3. The VFD's shall have efficiency at full load and speed that exceeds 95% for VFDs below 15 Hp and 97% for drives 15 Hp and above. The efficiency shall exceed 90% at 50% speed and load.
   4. The VFDs shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.
   5. The VFDs shall have a one (1) minute overload current rating of 150% and a two (2) second overload current rating of 250% for constant torque drives. The VFDs shall have a one (1) minute overload current rating of 110% for variable torque drives.

6. The VFDs shall be capable of operating of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
7. The VFD's shall have an integral EMI/RFI filter as standard.
8. The VFD's shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519-2014 for general systems applications, by utilizing the standard 5% nominal impedance integral AC three-phase line reactor.
9. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load. The calculations shall be made with the point of common coupling being the point where the utility feeds multiple customers.
10. Total harmonic distortion shall be calculated under worst-case conditions in accordance with the procedure outlined in IEEE standard 519-2014. Copies of these calculations are to be made available upon request. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to requiring harmonic calculations.
11. The system containing the VFDs shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-2014. If the system cannot meet the harmonic levels with the with the VFDs provided with the standard input line reactor or optional input isolation transformer, the VFD manufacturer shall supply either a 12-Pulse or an 18-pulse, multiple bridge rectifier ac to dc conversion section with phase shifting transformer or Matrix topology solution for all drives 50 Hp and above. This 18-pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sine-wave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability. Harmonic filters are not acceptable for drives 50 Hp and above.
12. The VFD's shall be able to start into a spinning motor. The VFDs shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFDs shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
13. Standard operating conditions shall be:
    a. Incoming Power: Three-phase, 208 - 240 / 380 - 500 / 525 - 690 Vac (+10% to -15%) and 50/60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
    b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
    c. Speed regulation of +/- 0.5% of base speed.
    d. Load inertia dependent carryover (ride-through) during utility loss.
    e. Insensitive to input line rotation.
    f. Power loss ride through shall be adjustable through 2 seconds.
    g. Humidity: 0 to 95% (non-condensing and non-corrosive).
    h. Altitude: 0 to 3,300 feet above sea level.
    i. Ambient Temperature: -10 to 50°C (CT), -10 to 40°C (VT).
    j. Storage Temperature: -40 to 60°C.
14. Control Functions
    a. VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFDs shall have a 5 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
    b. The keypad shall include a Local/Remote pushbutton selection. Both start/ stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.

c. The keypad shall have copy / paste capability.
d. Upon initial power up of the VFD, the keypad shall display a start up guide that will sequence all the necessary parameter adjustments for general start up.
e. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition, the software shall permit control and monitoring via the VFD's RS232 port. The manufacturer shall supply free website download for the required software. An easily understood instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this Section.
f. The operator shall be able to scroll through the keypad menu to choose between the following:
   1) Monitor
   2) Operate
   3) Parameter setup
   4) Display parameter values
   5) Display current faults
   6) Fault history
   7) Keypad LCD contrast adjustment
   8) Information to indicate the standard software and optional features software loaded.
g. The following setups and adjustments, at a minimum, are to be available:
   1) Start command from keypad, remote or communications port
   2) Speed command from keypad, remote or communications port
   3) Motor direction selection
   4) Maximum and minimum speed limits
   5) Acceleration and deceleration times, two settable ranges
   6) Critical (skip) frequency avoidance
   7) Torque limit
   8) Multiple attempt restart function
   9) Multiple preset speeds adjustment
   10) Parameter for speed search to catch a spinning motor start or normal start selection
   11) Programmable analog output
   12) DC brake current magnitude and time
   13) PI process controller

15. The VFDs shall have the following system interfaces:
   a. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and shall be provided with the following available as a minimum:
      1) Remote manual/auto
      2) Remote start/stop
      3) Remote forward/reverse
      4) Remote preset speeds
      5) Remote external trip
      6) Remote fault reset
      7) Process control speed reference interface, 4-20 mA dc
      8) Potentiometer and 1-10 Vdc speed reference interface
      9) RS232 programming and operation interface port
   b. Provide a communications interface with all points and functions listed in this section connected to the BMS provided. A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum.
      1) Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:

a) Fault
b) Run
c) Ready
d) Reversed
e) Jogging
f) At speed
g) Torque Limit Supervision
h) Motor rotation direction opposite of commanded
i) Over temperature

2) Programmable open collector output with available 24Vdc power supply and selectable with the following available at minimum:
   a) Fault
   b) Run
   c) Ready
   d) Reversed
   e) Jogging
   f) At speed
   g) Torque Limit Supervision
   h) Motor rotation direction opposite of commanded
   i) Over temperature

3) Programmable analog output signal, selectable with the following available at minimum:
   a) Motor current
   b) Output frequency
   c) Frequency reference
   d) Motor speed
   e) Motor torque
   f) Motor power
   g) Motor voltage
   h) DC-bus voltage

16. Monitoring and Displays
   a. The VFD's display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
      1) Run
      2) Forward
      3) Reverse
      4) Stop
      5) Ready
      6) Alarm
      7) Fault
      8) I/O terminal
      9) Keypad
      10) Bus/Comm
      11) Local / Remote (LED)
      12) Fault)
   b. The VFD's keypad shall be capable of displaying the following monitoring functions at a minimum:
      1) Output frequency
      2) Frequency reference
      3) Motor speed
      4) Motor current
      5) Motor torque
      6) Motor power
      7) Motor voltage
      8) DC-bus voltage

9) Unit temperature
10) Voltage level of analog input
11) Current level of analog input
12) Digital inputs status
13) Digital and relay outputs status
14) Analog out

17. Protective Functions
    a. The VFD shall include the following protective features at minimum:
        1) Over current
        2) Overvoltage
        3) Inverter fault
        4) Under voltage
        5) Input phase loss
        6) Output phase loss
        7) Under temperature
        8) Over temperature
        9) Motor stalled
        10) Motor under load
        11) Logic voltage failure
        12) Microprocessor failure
    b. The VFD shall provide ground fault protection during power-up, starting, and running. VFD's with no ground fault protection during running are not acceptable.
18. Diagnostic Features
    a. Ten (10) faults History
    b. Record and log faults
19. Indicate the most recent first, and store up to ten (10) faults.
20. Additional features that must be included in the VFD:
    a. Thermal or magnetic only circuit breaker to provide a disconnect means. Operating handle shall protrude the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the ON position. This shall be defeat able by maintenance personnel.
    b. Three (3) contactor bypass shall include a drive input disconnect, an VFD input isolation contactor, bypass contactor and an VFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit shall include control logic, status lights and motor over current relays. The complete bypass system (Inverter-Off-Bypass) (Hand-Off-Auto with Inverter-Bypass) selector switch(s), and inverter/bypass pilot lights shall be packaged with the VFD. The unit may be set up for (Manual or Automatic) bypass operation upon an VFD trip.
    c. Fused space heaters with thermostat for oversize enclosures to minimize condensation potential upon drive shutdown.
    d. Motor over-current relay to provide motor over current sensing of a given level of load current.
    e. Motor filter for use on motor cable runs exceeding 100 feet for motors with a peak voltage insulation rating less than 1600 Vac. Motors without NEMA MG1, Part 31 construction shall be identified to bidders.
        1) The dV/dt filter shall be located at the VFD and shall reduce the dV/dt clamp any voltage overshoots of the VFD output. It will return the energy in the voltage overshoots to the VFD's dc bus. A power dissipative resistance device is not acceptable. Filter shall be a Eaton MotoR$_x$™ series.

21. The VFD manufacturer shall maintain, as part of a national network, engineering service facilities within 250 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
   1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
   2. After all tests have been performed, each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
   3. After the burn-in cycle is complete, each VFD shall be put through a motor load test before inspection and shipping.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.2 FIELD QUALITY CONTROL

A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD’s on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer’s installation instructions, wiring, application dependent adjustments, communications setup and verification of proper VFD operation.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
   1. Inspection and final adjustments.
   2. Operational and functional checks of VFDs and spare parts.
   3. Provide cable and connector to the IP drop supplied by Controls Contractor.
   4. Verify that the unit is properly configured for remote communication to the system.
   5. The Contractor shall certify that he has read the drive manufacturer’s installation instructions and has installed the VFD in accordance with those instructions.

C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.3 MAINTNANCE / WARRANTY SERVICE

A. Warranty to commence twelve (12) months from the date of start-up, not to exceed 36 months from the date of shipment, and include all parts, labor, and travel time.

3.4 FIELD TESTING

A. The VFD manufacturer shall perform harmonic measurements at the point where the utility feeds multiple customers (PCC) to verify compliance with IEEE 519-2014. A report of the voltage THD and current TDD shall be sent to the engineer. The Contractor shall provide labor, material, and protection as needed to access the test points. The readings shall be taken with all drives and all other loads at full load, or as close as field conditions allow.

3.5 TRAINING

A. The Contractor shall provide a training session for up to two (2) Owner's representatives for one (1) workday with a maximum of two (2) trips at a job site location determined by the Owner. Training and instruction time shall be in addition to that required for start-up service.

B. The training shall be conducted by the manufacturer's qualified representative.

C. The training program shall consist of the following:
   1. Instructions on the proper operation of the equipment.
   2. Instructions on the proper maintenance of the equipment.

END OF SECTION 23 05 13

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23 05 39
SLEEVES, FLASHINGS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnish and install supports, anchors and sleeves applicable to mechanical, plumbing, and fire protection systems, including:
   1. Pipe, duct, and equipment hangers, supports, and associated anchors.
   2. Equipment bases and supports.
   3. Sleeves and seals.
   4. Flashing and sealing equipment and pipe stacks.

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Provide hanger and support inserts and sleeves and coordinate placement into formwork.

1.3 RELATED SECTIONS

A. Section 23 07 00 – HVAC Insulation.

B. Section 23 05 48 – Vibration Isolation and Wind Controls for HVAC Piping and Equipment.

1.4 REFERENCES STANDARDS

A. ASME Boiler and Pressure Vessel Code (BPVC), Section IX – Welding and Brazing Qualifications.

B. ASME B31.5 - Refrigeration Piping.

C. ASTM F708 - Design and Installation of Rigid Pipe Hangers.

D. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacturer .

E. IBC - International Building, 2015 edition with City of Stafford, Texas amendments.

F. IMC - International Mechanical Code, 2015 edition with City of Stafford, Texas amendments.

G. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.5 QUALITY ASSURANCE

A. Materials and application of pipe hangers and supports shall be in accordance with MSS SP-58 unless noted otherwise.

B. Support and sleeve materials and installation shall not interfere with the proper functioning of equipment.

C. Contractor shall be responsible for structural integrity of all hangers, supports, anchors, guides, inserts and sleeves. All structural hanging materials shall have a minimum safety factor of five (5).

D. Installer Qualifications: Utilize an installer experienced in performing Work of this Section who is experienced in installation of Work similar to that required for this Project. Field welding of

supports shall be by certified welders qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

1.6 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Shop Drawings: Submit detailed Drawings of all shop or field fabricated supports, anchors and sleeves, signed and sealed by a qualified State of Texas registered professional engineer. Indicate. Indicate system layout with location and detail of trapeze hangers, size and characteristics of components and fabrication details, and all loads exceeding 250 pounds imposed on the base building structure.

C. Product Data: Provide manufacturers' catalog data including load capacity and intended application.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of plumbing and hydronic, piping.

1.8 DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Maintain in place until installation.

C. Store materials protected from exposure to harmful weather conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Anvil International

B. B-line manufactured by Eaton

C. Enpro Industries, Inc. GPT

D. Hilti.

E. Kindorf® manufactured by Thomas & Betts

F. MIRO Industries, Inc.

G. Pipe Prop.

H. Piping Technology & Products, Inc.

I. Power-Strut® manufactured by Atkore International

J. Unistrut® manufactured by Atkore International.

2.2 PIPE HANGERS AND SUPPORTS

A. Ferrous Pipe Hangers:
1. Non-Insulated Pipe:
   a. Sizes 1/2 to 4-Inch: Provide malleable iron, adjustable swivel, split ring.
   b. 6-inches and Larger: Galvanized carbon steel, adjustable clevis with a nut above and below the hanger on the support rod.
2. Insulated Pipe: Galvanized carbon steel, adjustable clevis with a nut above and below the hanger on the support rod and insulation shield.
3. Single Hot Pipe Sizes 4 Inches and Over and Cold Pipe Sizes 4 Inches and Over: Carbon Steel Roller.
4. Multiple or Trapeze Hangers: Galvanized steel channels with welded spacers and hanger rods, cast iron roller and stand for sizes 4 inches and larger hot water piping and 4 inches and larger chilled water piping.
5. Carbon steel components of all pipe hangers in corrosive areas shall be hot dipped galvanized by Piping Technology & Products, Inc. or Engineer accepted equivalent.

B. Fasteners
1. Steel Beam Clamps: Anvil #134. Obtain written approval from Project Structural Engineer to suspend from bottom chord of bar joists and to use “C” type beam clamps.
2. Purlin Attachments:
   a. For Hanger Rod:
      1) nVent Erico #PHSW4 multi-flange rod hanger with swivel. Other means of attaching hangers to purlins shall be permitted only at the discretion of the Project Structural Engineer.
      2) Fastenal steel SAMMYS® #DST, Sammy “X-Press” or Sammy “Swivel Head” fasteners may be used on the bottom flanges of light gage steel purlins, only if approved by the Project Structural Engineer and the purlin manufacturer.
      3) Fastenal Sammy’s #SWDR “Sidewinder” fasteners may be used for attachment to the web of light gage steel purlins only if they are located at mid-span.
   b. For Metal Strut: Atkore Power-Strut® #PS 2653.

C. Wall Supports:
1. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
2. Wall Support for Pipe Sizes to 4 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roller.

D. Vertical Supports: Steel riser clamp.
1. Concealed Areas:
   a. Two (2) bolt riser clamps for pipe 12" in diameter and smaller shall be Anvil Figure 261 or Engineer accepted equivalent.
   b. Riser clamps for 14" and larger diameter pipes shall be four (4) bolt riser clamps designed for the load by the riser clamp manufacturer.
   c. Each end of riser clamp shall have equal bearing on the building structure, and located at each floor
   d. When piping is subject to expansion and contraction, provide spring isolators (see Section 23 05 48 - Vibration Isolation).

e. Where brass or copper lines are supported on trapeze hangers or Kindorf channels the pipes shall be isolated from these supports with plastic tape with insulating qualities, or strut clamps as manufactured by Specialty Products Company, Stanton, California.

2. Exposed Areas: Supports for vertical piping in exposed areas shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The Contractor shall use a drilled anchor as specified above, and use an Anvil No. 595 Socket Clamp with Anvil No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.

E. Floor Supports:
1. Floor Support for Pipe Sizes 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
2. Floor Support for Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

F. Roof Pipe Stands:
1. Support piping on roof with an engineered prefabricated system designed for installation without roof penetrations, flashing or damage to the roofing material.
2. Pipe sizes less than 1": All-weather, UV resistant, plastic pipe saddle and base with 3/4" Schedule 40 PVC, UV resistant conduit as the vertical connection. PVC conduit length shall be field determined and cut to the proper height to maintain minimum pipe slope. Pipe shall be secured to saddle using UV/weather resistant black nylon cable tie. Pipe Prop® or Engineer accepted equivalent.
3. Pipe size 1" and larger: Stainless steel adjustable height pipe stand with cadmium plated hardware and self-lubricating, heavy duty SBR rubber roller. Miro model RAH Series, in the size required for pipe size. Provide Miro support pad or walkway pad, compatible with roofing material under pipe stand.

G. Design hangers without disengagement of supported pipe.

H. Copper Pipe Support and Hangers:
1. Non-Insulated Pipe Sizes 3-inch and smaller: Anvil Fig. CT 99c, adjustable, copper plated carbon steel ring.
2. Non-Insulated Pipe Sizes 4-inch and larger: Anvil Fig. 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod.
3. Insulated Pipe of All Sizes: Anvil Fig. 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod.

2.3 THERMAL-HANGER SHIELDS

A. Shield for Insulated Piping 2 Inches and Smaller: 18 gauge galvanized steel shield over insulation in 180-degree segments, minimum12 inches long at pipe support.

B. Shield for Insulated Piping 2-1/2 Inch and Larger (Except Cold Water Piping): Use pipe support inserts.

C. Galvanized steel shields in 180-degree segments in accordance with following table:

Pipe	Metal Gauge	Shield Length

Pipe	Metal Gauge	Shield Length
2-1/2" to 5"	15	12"
6" to 12"	14	24"
Over 12"	12	24"

2.4 HANGER RODS

A. Steel, threaded on both ends or one on one end or continuous threaded. Galvanized or cadmium plated.

2.5 CONCRETE INSERTS

A. Provide malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms, size inserts to suit threaded hanger rods.

2.6 FLASHING

A. Metal Flashing: 26 gauge galvanized steel.

B. Flexible Flashing: 47 mil thick sheet butyl: compatible with roofing.

C. Caps: Steel, 22 gauge minimum; use 16 gauge at fire resistant elements.

2.7 EQUIPMENT BASE AND SUPPORTS

A. Provide 6" concrete pads and equipment bases for all outdoor equipment on grade, floor mounted equipment in main central plant area, areas with floor below grade, penthouse equipment rooms, floor mounted air handling units and where shown on Drawings.

B. Provide prefabricated curbs or roof mounted equipment with the equipment. Equipment curb must compensate for slopped roof deck as required to set equipment level.

2.8 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Floors: Form with 16 gauge galvanized steel.

B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Above Grade: Form with 18 gauge galvanized steel.

C. Sleeves for Pipes through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Provide prefabricated fire rated sleeves including seals, UL listed; or provide Schedule 40 galvanized steel, sized for minimum 1 inch space between sleeve and carrier pipe.

D. Sleeves for Pipe through Floor Supporting Riser Piping: Standard weight galvanized steel pipe.

E. Sleeves for Pipes through Roof: Standard weight galvanized steel pipe.

F. Sleeves for Round Ductwork: Form with galvanized steel.

G. Sleeves for Rectangular Ductwork: Form with galvanized steel.

H. Provide fire-stop compound at all penetrations of floor slabs or firewalls such that fire rating integrity of barrier is not lessened.

I. Caulk: Caulk all sleeves water and airtight.

J. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping. Provide pipe sleeves one size larger that the pipe it serves, including insulation, except where GPT Link Seal® casing seals are used.

K. Sleeves Penetration Walls Below Grade: Provide GPT Link-Seal® and sleeve as manufactured by Thunderline Corporation, Wayne, Michigan, for all pipes passing through walls below grade.

2.9 FINISHES

A. Prime coat and paint exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

B. Provide galvanized hangers and supports for all piping and ductwork located in crawlspace, pipe shafts, and above suspended ceiling spaces.

C. Provide hanger rods, bolts, nuts, and all metal parts coated with the same material as hangers.

2.10 ANCHOR BOLTS

A. Provide galvanized anchor bolts for all equipment placed on concrete pads or on concrete slabs of the size and number recommended by the manufacturer of the equipment.

B. Acceptable Product: Hilti Kwik Bolt® 3 or Engineer accepted equivalent approved by the Project Structural Engineer.

1.2 ELECTRICAL CONDUIT SUPPORTS

A. All electrical conduits shall be run parallel or perpendicular to adjacent building lines. Single conduits running horizontally shall be supported by "Caddy" or "Minerallac" type hangers from adequately sized rods (minimum 1/4") from the building structure. Where multiple conduits are run horizontally, they shall be supported on trapeze of "Unistrut" type channel suspended on rods or bolted to vertical building members. Conduit shall be secured to channel with galvanized "Unistrut" type conduit clamps or stainless steel "Unistrut" type "Uni-Clips". All hangers shall be fastened to the building structure in the same manner as specified above for pipe hangers above and below the hanger on the support rod.

PART 3 - EXECUTION

3.1 GENERAL

A. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.

B. All auxiliary steel required for supports, anchors, guides, etc. shall be provided by the Mechanical Trades unless specifically indicated to be provided by others.

C. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.

D. All supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

E. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of five (5) built in.

F. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.

G. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.

H. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.

3.2 PIPE HANGERS AND SUPPORTS

A. Support horizontal pipes as follows:

Pipe Size	Max.Hanger Spacing	Hanger Diameter
1/2 to 1-1/4 inch	6'-0"	3/8"
1-1/2 to 2 inch	8'-0"	3/8"
2-1/2 to 3 inch	10'-0"	1/2"
4 to 6 inch	10'-0"	5/8"
8 to 12 inch	10'-0"	7/8"
14 inch and Over	14''-0""	1"
C.I. Bell and Spigot (or No-Hug)	5''-0" and at Joints	
* For PVC and cast iron pipes, maximum hanger spacing shall not exceed 4 feet with 3/8" hanger rod and 5 feet with 5/8" hanger rod respectively.		

B. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.

C. Place a hanger within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support horizontal cast iron pipe adjacent to each hub, with five feet maximum spacing between fingers.

F. All vertical pipes shall be substantially supported at each floor line with Engineer approved steel riser clamps. Support vertical cast iron pipe at each floor at hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines where specified. Hangers for dual or low temperature insulation pipes shall bear on the outside of the insulation, which shall be protected by support

I. Support riser piping independently of connected horizontal piping.

J. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp, or other approved method. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action.

K. Isolate all copper or brass lines from all ferrous materials with approved dielectric materials. Hangers supporting and contacting plastic or glass piping shall be of equal design, but shall be padded with neoprene material or equal. The padding material and the configuration of its installation shall be submitted for approval.

L. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the Owner.

3.3 LOW PRESSURE DUCT SUPPORT SCHEDULE

A. All horizontal ducts up to and including 40 inches in their greater dimension shall be supported by means of No. 18 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets, or clamps and fastened to above inserts with toggle bolts, beam clamps or other approved means. Duct shall have at least one pair of supports 8' 0" on centers. Clamps shall be used to fasten hangers to reinforcing on sealed ducts.

B. Horizontal ducts larger than 40 inches in their greatest dimension shall be supported by means of hanger rods bolted to angle iron trapeze hangers. Duct shall have at least one (1) pair of supports 8'-0" on centers according to the following:

Angle Length	Angle	Rod Diameter
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" x 1/8	1/4"
8'-0"	2" x 2" x 1/8"	5/16"
10'-0"	3" x 3" x 1/8"	3/8"

C. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60". Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

3.4 MEDIUM PRESSURE DUCT SUPPORT SCHEDULE

A. All horizontal rectangular ducts shall have duct hanger requirements as follows:

Max. Duct Dimen.	Steel Rod	Galv. Steel Strap Width	Max. Spacing	Min.# of Hangers	Trapeze Size
0 through 18"	--	1" x 16 ga.	10'	2	--
19" through 36"	--	1" x 16 ga.	10'	2	--
37" through 60"	3/8"	1" x 16 ga.	8'	2	2" x 2" x 1/4"
61" through 120"	3/8"	1 1/2" x 12 ga	8'	2	2" x 2" x 1/4"
121" through 240"	3/8"	--	4'	3	2-1/2" x 2-1/2" x 3/16"

B. All horizontal round ducts shall have ducts hangers spaced 10'-0" maximum with requirements as follows:

Duct Diameter	Min. Hanger Size	No. Hangers	Hanger Ring Size
Up through 18"	1" x 16 gauge	1	1" x 16 ga.
19" to 36"	1" x 12 gauge	1	1" X 12 ga.
37" to 50"	1-1/2" x 12 gauge	1	1-1/2" x 12 ga.
51" to 84"	1-1/2" x 12 gauge	2	Support Bracing Angle

3.5 CONCRETE INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, provide inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.6 FLASHING

A. Provide flexible flashing and metal counter-flashing where sleeves, piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flexible sheet flash and counter-flash all curbs for mechanical equipment on roof with sheet metal; seal watertight.

3.7 EQUIPMENT BASES AND SUPPORTS

A. Coordinate installation of equipment bases of concrete type specified for all outdoor equipment on grade and floor mounted equipment in main central plant area, areas with floors below grade, penthouse equipment rooms floor mounted air handling units and where shown on Drawings.

B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment

C. Construct support of steel members. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed.

E. Provide base of a minimum height of 4 inches above finished grade and a width that projects a minimum of 3 inches beyond equipment on all sides. Bevel edges of base.

F. Prepare surface under bases by cleaning, clearing, chipping and roughing.

G. Provide curbs of 14 inches minimum height above roofing surface for installation of mechanical equipment on roof.

H. See Section 23 05 48 – “Vibration and Wind Controls for HVAC Piping and Equipment” for wind restraint requirements for equipment mounted outdoors.

3.8 CONCRETE FOUNDATIONS ("HOUSEKEEPING PADS")

A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, fans, air handling units, etc., shall extend 4" on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 6" nominal lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with Carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.

3.9 WALL, FLOOR AND CEILING PLATES

A. Except as otherwise noted, provide C.P. (chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except under floor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

3.10 SLEEVES

A. Provide sleeves for all pipe penetrations through walls, roof or slab above grade.

B. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.

1. Sleeve material for floors and exterior walls shall be Schedule 40 galvanized steel with welded water stop rings.

2. Sleeves through interior walls to be galvanized sheet metal with gauge as required by wall fire rating, 20 gauge minimum.

C. Set floor sleeves in position in formwork. Provide reinforcing around sleeves.

D. Extend sleeves through floors 2 inches above finished floor level, except that floor sleeves in stairwells shall be flush with the finished floor. Caulk sleeves full depth and provide floor plate. Floor sleeves shall extend above the finished floor as detailed on the Drawings,. Sleeves in walls shall be trimmed flush with wall surface. Refer to the details on the project Drawings. Where the details differ from these Specifications, the Drawings take precedence.

E. Where piping or ductwork penetrates floor, ceiling wall, close off space between pipe or duct and adjacent work with fire stopping insulation and seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration. When penetration is through a fire rated floor or wall, provide fire safe insulation so that the assembly, when complete, is UL listed and equals the fire rating of construction penetrated by the sleeve.

F. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a GPT Link Seal® closure where piping exits the building, or penetrates a wall below ground level. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc. All penetrations shall be of ample size to accommodate the pipe, duct, etc., plus any specified insulation. Install pipe in sleeve so that neither the pipe nor its insulation touches the sleeve at any point.

G. Install chrome plated steel escutcheons at finished surfaces.

H. Provide three (3) 6 inch long reinforcing rods welded at 120-degree spacing to the sleeve on all sleeves supporting riser piping 4 inches and larger. Embed reinforcing rods in concrete or grout to existing concrete.

I. Install sleeve assembly for walls below grade with 1/4-inch thick plate located in the middle of the wall.

J. Vermin proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Architect/Engineer.

K. Waterproofing:
1. The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.
2. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.
3. Seal space between pipe and sleeve watertight for all sleeves penetrating the roof.

L. Air Plenums: The space around piping, ductwork, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

M. Fireproofing: Seal all cable trays, pipe, conduit, duct, etc., penetrations through roof, fire-rated walls and floors with a foam or sealant as described below, that will form a watertight, vermin

tight barrier that is capable of containing smoke and fire up to 2000°F for two (2) hours. Sealing of cable trays and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed. For wet locations, the foam material shall be silicone RTV foam or an approved equal. For dry locations, premixed putty equal to Nelson Flameseal Firestop putty may be used.

3.11 ANCHOR BOLTS

A. Locate position of anchor bolts by means of suitable templates.

B. When equipment is placed on vibration isolators, secure equipment to the isolator and the isolator to the floor, pad or support as recommended by the vibration isolator manufacturer.

3.12 INSULATION SHIELDS

A. Protect insulation from crushing by means of a section of rigid insulation and a protective shield to be installed at hanger points. Provide insulation shields at every hanger support.

B. Provide shields of the proper length to distribute weight evenly and to prevent sagging or indentation of insulation at hanger.

C. Install shield so that hanger is placed at the center of the shield.

D. Attach shield to insulation with adhesive to prevent slippage or movement.

3.13 CONDUIT SUPPORTS

A. Spacing of hangers shall be adequate for the weight and rigidity of the conduits involved; in any case, no greater than 8' centers. Where feasible, conduits may be fastened to the concrete by one hole straps thoroughly anchored to the concrete in an approved manner. Flexible conduit shall also be supported in an acceptable manner so as not to interfere with the maintenance of above ceiling equipment, and to support it from touching the ceiling system. Conduit shall be located so as not to inhibit removal of ceiling tiles.

END OF SECTION 23 05 39

23 05 93
SYSTEM TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Documents, General Requirements for Building Construction and Related Work, apply to work specified in this section.

B. Coordinate with Commissioning Requirements indicated in Section 017500 – "Starting and Adjusting". This Contractor is responsible to comply with all requirements for the above section.

1.2 SCOPE

A. Testing, Adjusting and Balancing (TAB) contractor shall bid work specified under this section direct to school district. TAB Contractor shall not be hired by General Contractor or any subcontractor. Mechanical Contractor shall provide all assistance and information requested by the TAB Contractor.

B. This Section provides for the testing and balancing, of all systems and equipment. Refer to Section 23 08 00 for commissioning requirements.

C. These tests are required to determine that all systems and equipment involved may be safely energized and equipment.

D. Perform tests by and under the supervision of fully experienced and qualified personnel. Advise each respective manufacturer's representative of tests on their equipment.

E. Record all test data.

F. Each section of Division 23 that has the products or systems listed herein, incorporate this section by reference and is incomplete without the required tests stated herein.

G. This Section includes testing, adjusting, balancing HVAC systems and alarm point reporting verification to produce design objectives, including the following:
   1. Balancing airflow and water flow within distribution systems, including sub-mains, branches, and terminals, to indicated quantities according to specified tolerances.
   2. Adjusting total HVAC systems to provide indicated quantities.
   3. Measuring electrical performance of HVAC equipment.
   4. Testing, adjusting, and balancing of Hydraulic piping systems.
   5. Testing, adjusting, and balancing of refrigerating systems.
   6. Measurement of final operating condition of HVAC systems.
   7. Sound measurement of equipment operating conditions.
   8. Setting quantitative performance of HVAC equipment.
   9. Verifying that automatic control devices are functioning properly and perform their intended functions.
   10. Calibrating automatic temperature control sensors.
   11. Verification of building alarm and alarm remote monitoring.

1.2 QUALIFICATIONS

A. The independent testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or by the Associated Air Balance Council (AABC) in those testing

and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by NEBB or AABC as a Test and Balance Engineer.

B. The TAB firm shall have operated a minimum of five (5) years under its current Firm name, and shall be in good standing with the State of Texas, Franchise Tax Board. The firm shall submit their full incorporated name, Charter Number and Taxpayer's I.D. Number for proper verification of the firm's status.

C. The TAB firm shall be capable of providing a performance bond, by a bonding company licensed to do business in the State of Texas, if determined by the Owner that such a bond is required. The amount of the bond which may be required shall be equal to the cost of the proposal submitted, or in the case of more than one proposal, the sum of all such proposals and any awarded work in progress.

D. All personnel used on the job site shall be either professional engineers or engineering technicians, who shall have been permanent, full time employees of the firm for a minimum of six (6) months prior to the start of work for this specific project.

E. The TAB firm shall submit biographical data on the individual proposed who will directly supervise the TAB work, as well as other personnel scheduled to perform the technical work under the contract. It shall also submit a background record of at least five (5) years of specialized experience in the field of air hydronic system balancing, and shall possess properly calibrated instrumentation. The supervisory personnel for the TAB firm shall be registered engineers in the mechanical field and all of the employees used in the TAB firm shall be permanent, full-time employees of the firm.

F. Pre-Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct a conference with the Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of the system operation and readiness for testing, adjusting, and balancing.

G. Test, adjust, and balance the air systems before hydronic and refrigerant systems.

H. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within five degrees Fahrenheit (5 deg-F) wet bulb temperature of maximum summer design condition, and within ten degrees Fahrenheit (10 deg-F) dry bulb temperature of minimum winter design condition. Take final temperature reading during seasonal operation.

I. Approved TAB Contractors:
   1. Engineered Air Balance.
   2. National Precisionaire, LLC.

1.3 SERVICES OF THE MECHANICAL CONTRACTOR

A. Mechanical Contractor is responsible for coordinating work with the TAB Contractor. Mechanical contractor requirements are specified herein.

B. Contractor shall provide all volume dampers, balancing dampers, balancing valves, test ports and Pete’s plugs as required by the Testing and Balancing Firm.

C. Contractor shall furnish a set of sheet metal shop drawings and HVAC piping drawings to the Testing and Balancing Firm during the submittal phase and incorporate the Testing and Balancing Firm's mark-ups and requests into the project.

D. Contractor shall provide all required equipment to facilitate Testing and Balancing Firm's work. This coordination shall be included in the Contractor's base bid price.

E. Provide, correct, repair or replace deficient items or conditions found during the testing and balancing.

F. Provide replacement sheaves as directed by TAB Contractor to achieve scheduled air volumes.

G. For motors with a variable frequency drive, Contractor shall provide belt and sheave adjustment such that units deliver their design CFM when speed drive is at 60 hertz.

H. The General Contractor and appropriate sub-contractors shall turn over the completed job to the TAB Contractor before testing begins. The General Contractor shall ensure the system is fully operational, has been cleaned and new air filters installed in all air-handling units prior to requesting the TAB Contractor to perform his work

J. Verify systems are complete and operable before commencing work. Verify the following:
   1. Systems are started and operating in safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage is minimized.
   12. Re-sheave.

I. It shall be the responsibility of the General Contractor and appropriate sub-contractors to cooperate with the Owner's TAB Contractor in furnishing personnel during the test and balancing to make such adjustments and corrections specified by the TAB, including but not limited to sheave changes.

1.3 REPORTS

A. The TAB firm shall, as a requirement of the TAB contract, arrange with the Architect to compile one (1) set of mechanical specifications, all pertinent change orders, and the following:
   1. One (1) complete set of Drawings less the structural sheets.
   2. One (1) set of mechanical floor plans of the conditioned spaces. These Drawings shall be hard copy and PDF type to facilitate marking.

B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in this Specification Section will be available through the Construction Inspector.

C. Submit test report forms for review a minimum of thirty (30) days prior to requesting a final review by the Architect/ Engineer.

D. Furnish six (6) individually bound copies of test data. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements take, both prior to and after any corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation.

E. The Architect will retain on (1) copy and the Engineer will retain one (1) copy. The remaining four (4) copies will be returned to the Contractor for inclusion in the operation and maintenance manuals. Refer to Division 01 – Closeout Submittals.

1.4 REFERENCES

A. AABC - National Standards for Total System Balance, 7th edition, 2016.

B. ASHRAE 111-2008 (RA2017) - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. IMC – International Mechanical Code, 2015 edition with City of Stafford, Texas amendments.

D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.4 RESPONSIBILITIES OF THE TAB FIRM

A. The TAB personnel shall check, adjust, and balance the components of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents. It is the responsibility of the Mechanical Contractor to place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC Standards.

B. Liaison and Early Inspection:
   1. The TAB firm personnel shall support on the job the commissioning authority responsible to act as liaison between the Owner, Architect and Contractor. The following reviews (observations) and tests shall be performed by the TAB Agency:
      a. During the design stage, before the documents are finalized, review the mechanical Drawings and Specifications for balance ability and provide commentary.
      b. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc., that pertain to commissioning work and balance ability.
      c. Allow for a fixed number of trips to the project site, over and above those required for testing and balancing for inspection of installation of the mechanical piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems during the construction stage. These inspections shall be made prior to and/or at the above ceiling inspection. Commentary will be provided to the Owner's Designated Representative of each observation.
   1. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the Construction Inspector shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.

1.5 VIBRATION TESTS

A. Location of Points for Air Handling Unit Fans and all other Fans:
   1. Fan bearing, drive end.
   2. Fan bearing, opposite end.
   3. Motor bearing, center (if applicable)
   4. Motor bearing, drive end.
   5. Motor bearing, opposite end.

B. Test Readings.
   1. Horizontal, velocity and displacement.
   2. Vertical, velocity and displacement.
   3. Axial, velocity and displacement.

C. Normally acceptable readings, velocity and acceleration.

D. Unusual conditions at time of test.

E. Vibration sources (if non-complying)

1.6 FINAL AIR BALANCE

A. General: When systems are complete and ready for operation, the TAB Consultant will perform a final air balance for all air systems and record the results. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within ±5% of the value shown on the drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices and the device OBD for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown. The general scope of balancing by the TAB Consultant will include, but is not limited to, the following:
   1. Filters: Check air filters and filter media and balance only system with essentially clean filters and filter media. The Division 23 Contractor shall install new filters and filter media prior to the final air balance.
   2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required, the Division 23 Contractor shall make any required changes.
   3. Ampere Readings: Measure and record full load amperes for motors.
   4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.
   5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM (s) and temperatures, as applicable, at each fan, blower and coil.
   6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and HVAC terminal unit. At the time of reading record water flow and entering and leaving water temperatures (In variable flow systems adjust the water flow to design for all the above readings).
   7. Zone Air Flow: Adjust each zone of multizone units, each HVAC terminal unit and air handling unit for design CFM.

8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within +5% of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and Rooms that are negative exhaust air flow shall be set to design +10% and supply to design -5%. Positive areas will have opposite tolerances.
9. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data.
10. Maximum and minimum airflow on terminal boxes.

1.7 SOUND VIBRATION AND ALIGNMENT

A. Sound: Read and record sound levels at up to 15 locations in the building designated by the Engineer. All measurements shall be made using an Octave Band Analyzer. All tests shall be conducted when the building is quiet in the presence of the Engineer, if he so desires.

B. Vibration: Read and record vibration for all water circulating pumps, air handling units, and fans which have motors larger than 10 HP. Include equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed 1 mil on fans and 1 mil on pumps unless otherwise specified. Equipment manufacturers shall rectify all systems exceeding vibration tolerances.

1.8 TESTING OF TEMPERATURE CONTROL SYSTEMS

A. In the process of performing the TAB work, the TAB Agency shall:
1. Work with the Temperature Control Contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.
2. Verify that all control devices are properly connected.
3. Verify that all dampers and other controlled devices are operated by the intended controller.
4. Verify that all dampers are in the position indicated by the controller (open, closed or modulating).
5. Verify the integrity of dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units, terminal boxes and fire/smoke dampers.
6. Observe the calibration of all controllers.
7. Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.
8. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.
9. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.
10. Verify that all controller setpoints meet the design intent.
11. Check all dampers for free travel.
12. Verify the operation of all interlock systems.
13. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.

B. A systematic listing of the above testing and verification shall be included in the final TAB report.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SERVICES OF THE MECHANICAL CONTRACTOR

A. Examine the contract documents to become familiar with Project requirements and to discover conditions in systems design that may preclude proper TAB of systems and equipment.

B. Examine the approved submittals for HVAC systems and equipment.

C. Verify systems are complete and operable before commencing work. Verify the following:
1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Re-sheave.

D. Contractor shall provide all volume dampers, balancing dampers, balancing valves, test ports and Pete's plugs as required by the Testing and Balancing Firm. Contractor shall furnish a set of sheet metal shop drawings and HVAC piping drawings to the Testing and Balancing Firm during the submittal phase and incorporate the Testing and Balancing Firm's mark-ups and requests into the project. Contractor shall provide all required equipment to facilitate Testing and Balancing Firm's work. This coordination shall be included in the Contractor's base bid price.

E. Provide, correct, repair or replace deficient items or conditions found during the testing and balancing.

F. Provide replacement sheaves as directed by TAB Contractor to achieve scheduled air volumes.

G. For motors with a variable frequency drive, contractor shall provide belt and sheave adjustment such that units deliver their design cfm when speed drive is at 60 hertz.

3.2 SERVICES OF THE TESTING AND BALANCING CONTRACTOR

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

C. 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 INSTALLATION TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust fans and Equipment with Fans: +/- 5%
   2. Air Outlets and Inlets: +/- 5%

3.4 ADJUSTING

A. Verify recorded data represents actual measured or observed conditions.

B. Permanently mark settings of dampers and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

D. Report defects and deficiencies noted during performance of services, preventing system balance.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.5 PREPARATION

A. Follow industry standard practices and procedures for testing, balancing, as listed in Part 1 of this Section.

B. The A/E must be notified a minimum of 72 hours prior to any tests being conducted.

C. The TAB Contractor must be notified a minimum of five (5) working days prior to conduction any duct leakage tests and same must be present to witness all duct leakage tests.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in main ducts by pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches W.G. positive static pressure near building entries in clean rooms.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Where sufficient space in ducts is unavailable for pitot tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
      b. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
      c. Measure static pressure directly at the fan outlet or through the flexible connection.
      d. 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.
      e. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      a. Report the cleanliness status of filters and the time static pressures are measured.
      b. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
      c. 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.
      d. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
      e. 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, sub-main ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure airflow of sub-main and branch ducts.
   2. Where sufficient space in sub-main 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.
   3. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
   4. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.
   1. Measure air outlets and inlets without making adjustments.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set outdoor-air dampers at minimum and set return- and exhaust-air dampers at a position that simulates full-cooling load.
   2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   3. Measure total system airflow. Adjust to within indicated airflow.
   4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
   5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
   6. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
   7. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   8. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

9. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
10. Record final fan-performance data.

3.9 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 MECHANICAL EQUIPMENT

A. Verify the following:
1. Equipment is operable and in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Correct fan rotation.
7. Fire and volume dampers are in place and open.
8. Coil fins have been cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and operable.
11. Duct system leakage has been minimized.
12. Pretest components in the VFD. Provide factory certification of testing the entire VFD with varying induction motor loads for 24 hours prior to shipment.
13. Proper sequencing and operation of all DDC Control System components and equipment as required by ASHRAE Standard on Total Building Mechanical System operation.
14. Perform sound power level tests and provide required data on each occupied space adjacent to, above, or below mechanical/ air handling unit equipment rooms.
15. Perform vibration test and provide required data on each piece of air handling/ ventilation equipment or fan. Vibration testing must be complete in compliance with the requirements of ASHRAE – 1999 HVAC applications Handbook Chapter 46, Sound and Vibration Control and the maximum listed RMS values listed herein.

B. Duct Leakage:
1. Test all supply air ductwork, to include, but not limited to, downstream of all single zone and multi-zone air handling units, downstream of all VAV air handling units and upstream of fan powered terminal units at 2-1/2 inches of static pressure (except where this requirement would exceed the ductwork design pressure classification) to have a total leakage value not to exceed 2% of the total system airflow.

2. Test all supply, return, and exhaust air ductwork, to include, but not limited to, downstream of fan coil units and fan powered terminal units, upstream of air handling units, and upstream and downstream (where applicable) of fans at 1-1/2 inches of static pressure to have a total leakage value not to exceed 2% of the total system design airflow.
3. Ductwork that initially fails these tests shall be replaced, modified, resealed, etc. as required to meet the leakage requirement and then re-tested to ensure compliances.

3.11 FINAL TAB REPORT

A. General: The activities described in this section shall culminate in a certified final written report to be provided in quadruplicate (4) individually bound to the RCM. 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 with the data the date tested, personnel present, weather conditions, nameplate record of test instruments used and list all measurements taken after all corrections are made to the system.
   1. Record all failures and corrective action taken to remedy incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel.
   2. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the reports must have been made onsite by the permanently employed technicians or engineers of the firm.
   3. At the option of the Construction Inspector, all data sheets tabulated each day by TAB personnel shall be submitted for initial by the Construction Inspector. Those work sheets so initialed, or copies thereof, shall be presented as a supplement to the final TAB report.

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: Submit reports on forms approved by the Owner & Engineer which will include the following information as a minimum:
   1. Title Page
      a. Company Name
      b. Company Address
      c. Company telephone number
      d. Project name
      e. Project location
      f. Project Manager
      g. Project Architect
      h. Project Engineer
      i. Project Contractor’s Name and Address
      j. Project Identification Number
      k. Report date.
      l. Signature of TAB supervisor who certifies the report.
   2. Instrument List
      a. Instrument
      b. Manufacturer
      c. Model

d. Serial Number
e. Range
f. Calibration date
g. What test instrument was used for

3. Fan Data (Supply and Exhaust)
   f. Location
   g. Manufacturer
   h. Model
   i. Air flow, specified and actual
   j. Total static pressure (total external), specified and actual
   k. Inlet pressure
   l. Discharge pressure
   m. Fan RPM
4. Return Air/Outside Air Data (If fans are used, same data as for 3 above)
   a. Identification/location
   b. Design return air flow
   c. Actual return air flow
   d. Design outside air flow
   e. Return air temperature
   f. Outside air temperature
   g. Required mixed air temperature
   h. Actual mixed air temperature
5. Electric Motors
   a. Manufacturer
   b. HP/BHP
   c. Phase, voltage, amperage, nameplate, actual
   d. RPM
   e. Service factor
   f. Starter size, heater elements, rating
6. V-Belt Drive
   a. Identification/location
   b. Required driven RPM
   c. Driven sheave, diameter and RPM
   d. Belt, size and quantity
   e. Motor sheave, diameter and RPM
   f. Center-to-center distance, maximum, minimum and actual
7. Duct Traverse
   a. System zone/branch
   b. Duct size
   c. Area
   d. Design velocity
   e. Design air flow
   f. Test velocity
   g. Test air flow
   h. Duct static pressure
   i. Air temperature
   j. Air correction factor
8. Air Monitoring Station Data
   a. Identification/location
   b. System
   c. Size
   d. Area
   e. Design velocity
   f. Design air flow

g. Test velocity
h. Test air flow

9. Air Distribution Test Sheet
   a. Air terminal number
   b. Room number/location
   c. Terminal type
   d. Terminal size
   e. Area factor
   f. Design velocity
   g. Design air flow
   h. Test (final) velocity
   i. Test (final) air flow
   j. Pump Data
   k. Identification/number
   l. Manufacturer
   m. Size/model
   n. Impeller
   o. Service
   p. Design flow rate, pressure drop, BHP
   q. Actual flow rate, pressure drop, BHP
   r. Discharge pressure
   s. Suction pressure
   t. Total operating head pressure
   u. Shut off, discharge and suction pressure
   v. Shut off, total head pressure
   w. Pressure differential settings
10. Cooling Coil Data
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Entering air DB temperature, design and actual
   f. Entering air WB temperature, design and actual
   g. Leaving air DB temperature, design and actual
   h. Leaving air WB temperature, design and actual
   i. Air pressure drop, design and actual
11. Heating Coil Data
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual
   f. Entering air temperature, design and actual
   g. Leaving air temperature, design and actual
   h. Air pressure drop, design and actual
12. Sound Level Report
   a. Location (Location established by the design engineer)
   b. NC curve for eight (8) bands - equipment off
   c. NC curve for eight (8) bands - equipment on
13. Vibration Test on equipment having 10 HP motors or above
   a. Location of points:
      1) Fan bearing, drive end
      1) Fan bearing, opposite end
      2) Motor bearing, center (if applicable)

3) Motor bearing, drive end
4) Motor bearing, opposite end
5) Casing (bottom or top)
6) Casing (side)
7) Duct after flexible connection (discharge)
8) Duct after flexible connection (suction)

b. Test readings:
9) Horizontal, velocity and displacement
10) Vertical, velocity and displacement
11) Axial, velocity and displacement

c. Normally acceptable readings, velocity and acceleration
d. Unusual conditions at time of test
e. Vibration source (if non-complying)

14. Control verification indicating date performed and any abnormalities identified.
a. Point Location/Description
a. EMS Readout (Setpoint and Actual)
b. Actual Readout
c. Interlocks
d. Safeties
1) VSD Normal Operation
2) VSD Bypass Operation
e. Alarms
f. Sequences of Operation

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HVAC INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnish and install thermal insulation for mechanical and plumbing piping systems including jackets and accessories.

B. Insulation systems for sheet metal duct conveying cold and hot air. Provide duct insulation systems which have been manufactured, fabricated and installed to meet all thermal requirements of mechanical systems. Insulating systems shall be installed in strict accordance with manufacturer's field requirements and the 2015 International Energy Conservation Code.

C. HVAC system includes horizontal roof drain, lines, and waste lines which receive condensate from air handling units or evaporators.

1.2 RELATED SECTIONS

A. Section 09 01 90 – Maintenance of Painting and Coatings

B. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

C. Section 23 05 53 – Identification for HVAC Piping and Equipment.

1.3 REFERENCES

A. ASTM C178 – Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-HOT-Plate Apparatus.

B. ASTM C195 – Mineral Fiber Thermal Insulation Cement.

C. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation.

D. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation.

E. ASTM C547 – Mineral Fiber Preformed Pipe Insulation.

F. ASTM C591 – Preformed Cellular Polyurethane Thermal Insulation.

G. ASTM C1126 – Rigid Cellular Phenolic Thermal Insulation.

H. ASTM B209 – Aluminum and Aluminum-alloy Sheet and Plate.

I. ASTM E84 – Surface Burning Characteristics of Building Materials.

J. ASTM E96 –Water Vapor Transmission of Materials.

K. IECC - International Energy Conservation Code, 2015 edition with City of Stafford, Texas amendments.

1.4 SUBMITTALS

A. Include product description, list of materials, and thickness for each service and locations.

B. Include detail drawings of insulation dams.

1.5 QUALITY ASSURANCE

A. Application Company Qualifications: The installing company must be solely and exclusively in the business of insulation installation for the previous consecutive five (5) year period. The installing company must also be regularly engaged in installing the specific specified insulation material types on projects of equal or greater magnitude and scope as this project for the previous consecutive five (5) year period. Documentation of the above listed requirements must be submitted prior to insulation material submitted.

B. Application Personnel Qualifications: The installing company must provide qualified installation personnel on this project jobsite directly employed by them who are skilled and proficient at installing the specific specified insulation material types.

C. Any material found, by the A/E, to be improperly installed or not installed in total compliance with the specific installation instructions and methods (written or implied) of the material manufacturer must be removed by the installing company. The preparation instructions must be followed prior to the re-installation of the insulation material using the correct installation instructions and methods of the material manufacturer.

D. All material (to include, but not limited to, insulation, jackets, facings, coatings, mastics, adhesive, sealants, etc.) Installed inside the building must have a certified and tested composite flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

B. All insulation shall comply with IECC 2015.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Insulation
1. Owens-Corning Fiberglass Corporation.
2. UpJohn CRP/DOW Chemical Company.
3. Knauff Corporation.
4. FGH Fabricators, Inc.
5. Armstrong.
6. Quiet Liner™ by Acoustical Surfaces, Inc.

B. Jackets
1. Childers Products Company.
2. PABCO.
3. RFR Products, Inc.
4. Kinetics Duct Wrap.

2.2 PIPE INSULATION

A. Type A: Foamglas® 2.2 # density as manufactured by Pittsburg Corning, Inc. preformed insulation: ASTM C547; minimum 3.0 lb/cu ft density, ASTM C335, 'k' value of 0.23 at 75 degrees F; noncombustible.

B. Type B-1: Elastomer, closed cell, flexible, insulation; ASTM E 96, maximum vapor transmission rating of 0.20 pers; ASTM C177; 'k' value of 0.27 at 75 degrees F.

C. Type B-2: Fiberglass Piping Insulation: ASTM C547, Class 1 unless otherwise indicated. (Indoor locations only).

D. Type B-3: Phenolic
   1. Manufacturers:
      a. Kingspan Corp.; Koolphen K.
      b. ReSolco Model Insul-phen.
      c. Kooltherm Insulation Products.
   2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
      a. 'K' ('ksi') factor: ASTM C177 or ASTM C518, 0.19 at 75°F (24°C).
      b. Maximum Service Temperature: 300°F (149°C).
      c. Minimum Service Temperature: 297°F (147°C).
      d. Maximum Moisture Absorption: 0.2 percent by volume.
   3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
   4. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
      a. Preformed Pipe Insulation: ASJ.
      b. Board for Duct and Plenum Applications: ASJ.
      c. Board for Equipment Applications: ASJ.

E. Type B-4: Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
   1. Manufacturers:
      a. Apache Products Company; ISO-25.
      b. Dow Chemical Company (The); Trymer.
      c. Duna USA Inc.; Corafoam.
      d. Elliott Company; Elfoam.
   2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
   3. Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation: ASTM C591, Type III, compressive strength 50 psi (345 kPa).
      a. 'K' ('ksi') factor: ASTM C177 or ASTM C518, 0.19 at 75°F (0.027 at 24°C).
      b. Maximum Service Temperature: 300°F (149°C).
      c. Minimum Service Temperature: 297°F (147°C).
      d. Maximum Moisture Absorption: 0.2 percent by volume.
   4. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm) as tested by ASTM E 84.
   5. Fabricate shapes according to ASTM C 450 and ASTM C 585.
   6. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
      a. Pipe Applications: ASJA.
      b. Equipment Applications: ASJASJ or ASJ-SSL.

2.3 DUCT INSULATION MATERIALS

A. Type C: Flexible Fiberglass Duct Insulation (Indoor application): ASTM C 553, Type I, Class B 4, 2 " thick, 1.0 PCF density, minimum R-6 (installed) with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.

B. Type D: Rigid Fiberglass Duct Insulation (Indoor application): ASTM C 612, Class 1, 2" thick, 3.0 PCF densities, for both supply and exhaust round ducts exposed to view locations, or spaces without ceilings. Round duct insulation shall be E. O. Wood Rigid wrap® for all round ducts in areas without ceiling.

C. Type E: Rigid Foam Glass Duct Insulation (Outdoor application): Foamglas ONETM block with 7.3 lbs/ft3 and 0.29 BTU-inch /hr F thermal conductivity per ASTM C 240, Type I.

D. Type F: Quiet Liner by Acoustical Surfaces Inc. or approved equal. Quiet Natural Fiber Liner shall be thermally bonded HVAC insulation with superior acoustic and thermal performance. Liner shall be made from natural fibers; Quiet Liner™ shall not contain fiberglass. The fibers used to manufacture Quiet Liner shall offer sound absorption properties. The air stream surface shall be overlaid with a durable, fire-resistant black facing, to provide additional strength to the product. Both the insulation and the facing shall be treated with an EPA registered anti-microbial agent. Surface Burning Characteristics shall be less than 25/50 shall be Class A / Class 1 per ASTM E84, UL 723, and NFPA 255. Fungi Resistance shall indicate no growth per ASTM C1338 and ASTM C739. Water Vapor Absorption shall be less than 1% by weight per ASTM C1104.

E. Jackets for Duct Insulation: ASTM C 921, Type I for duct with temperatures below ambient; Type II for duct with temperatures above ambient.

F. Jackets for Outdoor Duct Insulation: Encase exterior duct insulation with 16 MIL Stainless steel jacket with "Z" closures for weather proof construction.

G. Duct Insulation Accessories: Provide bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

H. Mechanical Fasteners:
   1. Gemco Type IH-A from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
   2. Eckoustic-Klip from Eckel Industries Inc., Cambridge, MA 617-491-3221.
   3. INC Stick-Pin from Industrial Noise Control Inc. Addison, IL 312-620-1998.

I. Duct Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.
   1. 15-141 from King Co., St. Louis, MO 314-772-9953.
   2. Tuffbond from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
   3. INC C-700 from Industrial Noise Control Inc., Addison, IL 312-620-1998.

J. All external duct wrap shall be 2" thick, 1.0 PCF density minimum, and is required on all and supply air duct that also meets with the minimum R-value per International Energy Conservation Code 2015. External duct wrap shall be with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.

2.4 DUCTWORK JACKETS

A. Interior, Concealed Applications:

1. Type D Insulation: One and a half (1-1/2) pounds per cubic feet minimum density semi-rigid glass fiber. Provide factory applied ASJ white kraft foil vapor barrier.
2. Type B Insulation: Finish coat is not required.
3. Insulate fittings, joints and valves with molded insulation of like material and thickness as adjoining pipe. Use insulating cement to fill voids and cracks. Finish with #10 glass membrane and Childers #CP-30 L.O. vapor barrier mastic.

B. Interior, Exposed Applications
1. Double wall duct and fittings will consist of a solid inner liner, 1" thick x 1.0 lb/ft3 layer of glass fiber insulation, and a solid outer pressure shell.
2. Double wall jacket with spiral lockseam with standing rib.
3. Fitting ends shall be sized to slip-fit into spiral duct of the same nominal size.

C. Exterior Applications
1. Prime sheet metal with Pittcote 300 before the installation of insulation.
2. Insulate exterior ductwork with two (2) layers of 1 1/2" thick FOAMGLAS sheet.
3. Wrap insulation with 8 oz canvas. Finish with 2 coats on 8 oz canvas shall be Childers CP-50 prior to final jacket installation.
4. Cover with 0.02 inch thick stainless steel jacket having integral moisture barrier with seams located at 2 or 10 o'clock position of horizontal piping. All laps must be minimum 2".

D. Jacket Materials
1. Factory Applied Jackets: White kraft bonded to reinforced foil vapor barrier with self-sealing adhesive joints.
2. PVC Jackets: One (1) piece, pre-molded type, to meet flame spread and smoke developed rating of 25/50 in accordance with ASTM E84.
3. Canvas Jackets: UL listed treated cotton fabric, 8 ounces per square
4. Fiberglass Cloth Reinforcing Mesh: #10 glass cloth with minimum weight of 3.9 ounces per square yard.
5. Aluminum Jackets (Indoor applications exposed to view): ASTM B209, 0.020 inch thick; smooth finish with factory applied moisture barrier.
6. Stainless Steel Jackets (Outdoor applications): Type 304 stainless steel; 0.010 inch thick; smooth finish.

2.5 ACCOUSTICAL DUCT WRAP (TYPE L)

A. The sound control lagging material is applied continuously as part of the duct system to reduce sound transmission from the duct i.e., control breakout noise.

B. Material shall consist of a rugged, reinforced aluminized-faced, mass loaded limp vinyl barrier, 2-psf. Material shall be non-lead composition for safe handling and easy installation.

C. Pipe and duct shall be wrapped with fiber glass batt or other appropriate resilient material in order to decouple sound control lagging from surface of pipe and duct. For the required optimal performance, sound control lagging shall be installed / wrapped over the duct thermal insulation and shall not be applied directly to surface of duct.

D. The sound control lagging material shall be provided by a manufacturer having a minimum of five (5) years' experience in furnishing similar noise control lagging material for pipe and duct.

E. The barrier shall be constructed of a 0.24" thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 2.0-psf.

F. Sound control lagging material shall be Kinetics Noise Control, Inc. Model KNM-200AL or equal.

G. Products not meeting minimum test standards will not be accepted. Submittals shall include test reports from independent laboratories meeting the following minimum criteria:

H. Insertion Loss when tested as a duct wrap over 2" thick, 5-pcf fiberglass over a 20-gauge duct system (per ASTM E1222-90)

Frequency (Hz)	63	125	250	500	1000	2000	4000
Insertion Loss (dB)	5	9	18	28	34	37	37

2.6 ACCESSORIES

A. Insulation Bands: 3/4 inch wide; 0.015 inch thick galvanized steel, stainless steel or 0.007 inch thick aluminum.

B. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel to match jacket.

C. Insulating Cement: ASTM C195; hydraulic setting mineral wool; Ryder One-Coat.

D. Sealants: Used at valve, fittings and where insulation is terminated. Brushes apply sealant to end of insulation and continued along pipe surface. Provide Childers CP-30 L.O. sealant.

E. Adhesives: Used to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between insulation or fitting covers. Provide Childers CP-82 or approved equal as general purpose adhesive. Use Childers CP-97 fibrous adhesive for calcium silicate or when adhering pipe saddles and shields to the insulation.

F. Primers: Provide Childers CP-50 diluted 50% with water primer to cover insulating cements prior to finish coating.

G. Finish: Provide Childers CP-30 L.O. as a general purpose finish to coat the longitudinal seams and butt joints of vapor barrier jackets or glass cloth jackets. Use Childers CP-50 reinforced with glass cloth as an adhesive and seizing for canvas and in other locations as indicated.

PART 3 - EXECUTION

3.1 PIPE PREPARATION

A. Thoroughly clean all surfaces to be insulated as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping must be completely dry at the time of application.

B. The installation of piping insulation associated with an operating chilled water system is strictly prohibited.

C. Provide primer coat on all piping, to include field welds and over factory applied paint/coating, in total compliance and compatible with and approved by the Engineer prior to installation of insulation (No Exceptions).

D. Install insulation material only after all performance tests on piping have been completed and approved by the Engineer (No Exceptions).

3.2 PIPE INSULATION INSTALLATION

A. Install materials in complete and total compliance with the specific manufacturer's published installation instructions.

B. Continue vapor barrier through wall and floor penetrations.

C. In exposed piping, locate insulation and cover seams in least visible locations.

D. Insulate fittings, valves, flanges and strainers. On flexible connections, expansion joints and unions, bevel and seal ends of insulation and continue sealant a minimum of 4 inches along the piping.

E. Provide dams in insulation at intervals not to exceed 20 feet to prevent migration of condensation or leakage.

F. Provide an insert of same thickness and contour as adjoining insulation, between support shield and piping, and under the finish jacket, on piping 2-1/2 inch diameter or larger, to prevent insulation form sagging at support points. Provide inserts for 180-degree arc and not less than the length of the pipe support shield or minimum 12 inches long (whichever is greater) manufactured of 5.0# density cellular phenolic insulation material suitable for the planned temperature range. Factory fabricated inserts with integral galvanized pipe saddles are recommended. Adhere pipe support shield to insulation with adhesive.

G. Neatly finish and seal insulation at supports, protrusions and interruptions. Maintain vapor barrier with finish coat.

H. Paint exposed pipe insulation in total compliance with Specification Section 23 05 53 and Section 09 01 90.

3.3 DUCT SYSTEM INSULATION

A. Insulate all supply, return fresh-air, outside-air, make-up air and exhaust ducts. Ducts shall be externally insulated, except as required for sound control where noted on the Drawings or in these Specifications.

B. Cold Ducts:
   1. Temperatures below the space dew point shall have the insulation vapor barrier be continuous and unbroken through inside walls, sleeves and floor openings. Where connection is made to fire or fire/smoke damper in wall or floor the vapor barrier must extend to the wall or floor to prevent ambient air water vapor from condensing on the cold surfaces of the fire damper.
   2. Below Ambient Temperature:
      a. Application Requirements: Insulate the following cold duct:
         1) Outdoor air intake duct between air entrance and fan inlet or HVAC unit inlet.
         2) HVAC supply duct between fan discharge, or HVAC unit discharge, and room terminal outlet.
         3) Insulate neck, backside, and bells of supply diffusers.
         4) HVAC return duct between room terminal inlet and return fan inlet, or HVAC unit inlet.
         5) HVAC plenums and unit housings not pre insulated at factory or lined.
         6) Exhaust ductwork within the building non air-conditioned spaces.

C. Duct Wrap:
   1. Fasten all longitudinal and circumferential laps with outward clinching staples 3" on center. On rectangular ducts over 24" wide, apply as above and hold insulation in place on bottom side with mechanical pins and clips on 12" centers.
   2. Seal all joints, fastener penetrations and other breaks in vapor barrier with 3 inch wide strips of the same facing materials with factory applied vapor barrier adhesive, or 3 inch wide strips of white glass fabric embedded between two coats of vapor barrier mastic, Childers CP-30 or approved equal.

D. Insulate each duct system specified above with one of the following types and thicknesses of insulation:
   1. Rigid Fiberglass: 2" thick, 3.0 PCF density, for both supply and exhaust round ducts exposed outdoor locations, or spaces without ceilings. Round duct insulation shall be E. O. Wood Rigid wrap® for all round ducts in areas without ceiling.
   2. Flexible Fiberglass: 2" thick, 1.0 PCF density, minimum R-6 with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.
   3. Cellular Glass: two (2) layers of 1" thick insulation blocks or 2" thick Armstrong Type II Armaflex flexible elastomeric closed cell sheet insulation or approved equal. (For outdoors locations).

E. Ductwork exposed to view, any other exposed indoor locations, indoor non-conditioned spaces, or spaces without ceilings shall be double wall construction.

F. Exhaust ductwork within the air-conditioned spaces do not require to be insulated. Exhaust duct on roof exposed to the outside weather do not require to be insulated.

3.4 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Insulated ductwork conveying air below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:
   1. Provide with or without standard vapor barrier jacket.
   2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. For ductwork exposed in finished spaces, finish with aluminum jacket.

E. External / Outdoor Duct Insulation Application:
   1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive to match jacket.
   2. Secure insulation without vapor barrier with staples, tape, or wires.
   3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
   4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
   5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

6. Install 0.02" thick smooth stainless steel jacket on ductwork installed outdoors / on roof.

F. The sound control lagging material is critical in order to achieve the desired noise reduction. Sound control lagging material shall be cut to length, wrapped around the outside of the duct, and fastened with mechanical fasteners or bands. Tape and adhesive can be used in conjunction with mechanical fasteners or bands. All sound control lagging materials must be installed per the manufacturer's installation guidelines.

G. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
3. Seal and smooth joints.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

H. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

I. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

J. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

K. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable.

L. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

M. Extreme care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and all mixing boxes) ductwork to

insure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.

N. Where specified, aluminum bands shall be used on piping insulation. The bands shall be applied three (3) to a section of pipe. Fittings, valves, etc., shall have bands on each side.

O. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

P. Provide 2 hour enclosure on grease exhaust duct. Enclosure shall extend from kitchen hood to underside of roof deck.

Q. All ductwork downstream from the VAV terminal units shall be provided with acoustical wrap / lagging over and above the duct insulation. Sound control lagging material shall be Kinetics Noise Control, Inc. Model KNM-200AL or equal.

R. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer's recommendations.

3.5 INSULATION SCHEDULE

DUCT OR PIPING	TYPE	DUCT / PIPE SIZE	INSULATION THICKNESS
Condensate Drain Lines (Interior Exposed)	B-1	All Sizes	1"
Refrigerant Suction Piping	B-1	2" & Smaller	1-1/2"
Indoor Ductwork Insulation Concealed Spaces	C	All Sizes	2" Thick & 1.0 lbs. Density
All Ductwork Downstream from the VAV Terminal Units	L	All Ducts All Sizes	1" Thick & 2 lbs. Density.
Acoustical Ductwork Liner First 20 Feet from All AHU's	F	All Sizes	2" Thick & 1.5 lbs Density
Indoor Ductwork Insulation (Non-Concealed Spaces) Provide Aluminum Jacket	D	All Sizes	2" & 3.0 Lbs Density
Outdoor Ductwork Insulation Provide 0.020"X 36" Smooth Stainless Steel Jacket	E	All Sizes	Two (2) Layers of Rigid 1" Thick, and 7.3 lbs/ft^3 Density

END OF SECTION 23 07 13

23 08 00

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC systems, assemblies, and equipment.

B. Related Sections:
1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.
2. Section 01 75 00 – Startup and Testing.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.5 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the C_xA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the C_xA.

E. Provide information requested by the C_xA for final commissioning documentation.

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.

1.7 C_xA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISSIONING DOCUMENTATION

A. Provide the following information to the C_xA for inclusion in the commissioning plan:
   1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
   2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
   3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC systems, assemblies, equipment, and components to be verified and tested.
   4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
   5. Certificate of readiness certifying that HVAC systems, subsystems, equipment, and associated controls are ready for testing.
   6. Test and inspection reports and certificates.
   7. Corrective action documents.
   8. Verification of testing, adjusting, and balancing reports.

1.9 SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set 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).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 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 ten (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 CxA will notify testing and balancing Contractor ten (10) days in advance of the date of field verification. Notice will not include data points to be verified.
   2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
   3. Failure of an item includes, other than sound, 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. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
   4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC testing shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. 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.

D. The CxA along with the HVAC Contractor, testing and balancing Contractor, and HVAC Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load 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.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. HVAC Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

B. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

C. HVAC Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC terminal equipment and unitary equipment.

D. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation controls.

END OF SECTION 23 08 00

23 31 13
METAL DUCTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. HVAC air distribution ductwork.

B. Duct pressure testing.

1.2 RELATED WORK

A. Section 09 90 00 - Painting: Weld priming, weather resistant, paint or coating.

B. Section 23 05 39 - Sleeves, Flashings, Supports and Anchors.

C. Section 23 05 93 - System Testing, Adjusting & Balancing.

D. Section 23 07 13 - HVAC Insulation.

E. Section 23 33 00 - Ductwork Accessories.

1.3 REFERENCES

A. ASHRAE – Fundamentals Handbook, Latest Version; Duct Design.

B. ASHRAE - HVAC Systems and Equipment Handbook, Latest Version; Duct Construction.

C. ASTM A90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

D. ASTM A525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

E. ASTM A527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

F. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

G. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

H. SMACNA – HVAC Duct Construction Standards, Metal and Flexible.

I. SMACNA - HVAC Air Duct Leakage Test Manual.

J. UL 181 - Factory-Made Air Ducts and Connectors.

K. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

L. IMC – International Mechanical Code, 2015 edition with City of Stafford, Texas amendments.

1.4 DEFINITIONS

A. WG - Water Gauge

B. Static Pressure - Total air pressure less velocity air pressure. Static pressure type is defined as positive or negative pressures relative to standard atmospheric conditions unless denoted otherwise.

C. Duct Size - Net inside clear dimensions after insulation. Where offsets or transitions are required, the duct shall maintain the equivalent area based on hydraulic diameter and rectangular duct size for equal flow, velocity and pressure drop as calculated by Huebscher Formula #30 and/or #31 in ASHRAE Duct Design Fundamentals Handbook and associated Friction Chart for round duct.

D. Pressure Classification - SMACNA standard classification system for ductwork applications not exceeding listed static pressure and velocity services. SMACNA standard static pressure classes are defined as follows:

Pressure Class	Operating Pressure (WG)	Pressure Type	Max Velocity (fpm)	Seal Class (Note 1)
1/2	< 1/2"	Any	< 2,000	C
1	>1/2" to 1"	Any	< 2,500	C
2	>1" to 2"	Any	< 2,500	B (Note 2)
3	>2" to 3"	Any	< 4,000	B
4	>3" to 4"	Positive Only	< 4,000	A
6	>4" to 6"	Positive Only	As Indicated	A
10	>6" to 10"	Positive Only	As Indicated	A

1. Note 1: Seal Classes shown for indoor applications; all exterior applications require Seal Class A regardless of pressure classification.
2. Note 2: Seal Class B required exceeding SMACNA minimum requirement.

1.5 SUBMITTALS

A. Refer to other applicable sections for additional coordination drawings, duct shop drawings and product data and conform to provisions of Division 1.

B. Shop Drawings:
1. Prepare and submit ductwork shop drawings prior to fabrication and installation of ductwork. Contract documents are schematic in nature and are not an acceptable substitute for ductwork shop drawings.
2. Include floor plans drawn to scale not less than 1’=1/4” over appropriate project backgrounds. Include duct elevations and sections where proposed duct configurations cannot be fully depicted in plan view.
3. Include relevant details such as duct size dimensions, pressure classification, sheet metal gages, joining methodology, duct construction technology, fittings and duct accessories prior to start of work.
4. Include coordination with the work of other applicable trades including architectural partitions, piping, electrical, lighting, and ceiling systems.

5. Indicate bottom of duct elevation dimensions.
6. Include details for offsets and transitions as required to permit ductwork to fit in the installation space allocated. Verify actual project field conditions and measurements as required.
7. Owner assumes no responsibility for reimbursing additional costs for duct revisions and/or rework required as a result of failure to prepare fully developed and detailed shop drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and protect products under provisions of Division 1.

B. Protect duct from exposure to weather. Do not store duct in uncovered areas.

C. The Contractor shall ensure that all ductwork either stored on site or installed in the building is thoroughly sealed to protect against dirt and moisture until such time that the building is deemed by the Owner to be adequately clean to allow for start-up of the associated air handling equipment. Should ductwork not be sealed as specified, then the Contractor shall have such ductwork professionally cleaned to an as-new condition at no cost to the Owner.

D. Prevent entry into and/or habitation of ductwork by animals during storage and construction.

E. Restore ductwork to like-new condition or replace contaminated by lack of adequate protection at no additional cost to Owner.

1.2 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

1.7 QUALITY CONTROL

A. Obtain manufacturer's inspection and acceptance of installation of duct at beginning of installation for factory prefabricated duct systems.

B. Provide 100% visual inspection of duct joint sealing prior to installation of thermal insulation coverings.

C. All material (to include, but not limited to, insulation, jackets, facings, coatings, mastics, adhesive, sealants, etc.) Installed inside the building must have a certified and tested composite flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.

1.8 PRESSURE TESTING

A. Pressure test ducts rated for Pressure Class 3 inch or higher.

B. Conduct tests using procedures consistent with SMACNA HVAC Air Duct Leakage Test Manual.

C. Determine maximum acceptable rate of air leakage using duct leakage formula as follows:

$$F = C_L \times P^{0.65}$$

Where:

F = Maximum permissible airflow leakage in cfm/100 sq. ft. duct surface
P = Ducts static pressure in inch WG
C_L = Leakage Class according to the table below

Duct Construction	Seal Class A	Seal Class B
Rectangular Construction	$C_L = 6$	$C_L = 12$
Round or Oval Construction	$C_L = 3$	$C_L = 6$

D. Conduct duct leakage tests witnessed in writing by Owner's designated representative, independent TAB service, project commissioning authority, independent construction inspector, engineer of record, and/or authority having jurisdiction where required. Schedule testing with advance notification for test witness(s).

E. Correct and retest ducts failing leakage tests at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Non-combustible and conforming to requirements for Class 1 air duct materials, or UL 181.

B. Non-Welded Steel Ducts: ASTM A525 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per sq. ft. for each side in conformance with ASTM A90.

C. Welded Carbon Steel Ducts: ASTM 568 rolled carbon steel; SMAW, FCAW, or GMAW welded; minimum 18 gauge sheet metal thickness.

D. Aluminum Ducts: Aluminum Alloy 3003, Temper H-14, minimum yield strength 21,000 lb/in^2.

E. Fasteners: Rivets, bolts, or sheet metal screws matching base duct materials.

F. Sealant: Non-hardening, water resistant, fire resistive, suitable for applications and compatible with mating materials
   1. High solids mastics - high density type with excellent adhesions and elasticity suitable for sealing fillets, groves, and flanges.
   2. Liquid sealants - formulated specifically for duct applications containing not more than 60% volatiles suitable for filling voids 1/16 inch or less. Provide taped joint reinforcement for liquid sealants except machine fabricated longitudinal seams and slip-type joints.
   3. Reinforcing tapes - suitable for use with liquid sealed joints only. Pressure sensitive adhesive tape sealing systems are not acceptable without liquid mastic overcoat.
   4. Gaskets: soft elastomeric butyl rubber with adhesive backing suitable for use with flanged joints.
   5. Liquid sealants containing not more than 50% volatiles. May be used for slip type joint assembly to fill voids up to 1/16 inch clearance.

G. Hangers:
   1. Strap: Steel, galvanized.

2. Rod: Steel, galvanized; continuously threaded.

2.2 CONSTRUCTION

A. Galvanized Steel Rectangular Duct:
   1. Single or double wall construction as indicated by application.
   2. Minimum 26 gauge sheet metal thickness.
   3. Longitudinal seams complying with the following industry standards:
      a. Inside Groove Seam.
      b. Sliding Seam.
      c. Pittsburgh Lock.
      d. Button-Punch Snap Lock.
   4. Transverse joints complying with the following industry standards:
      a. Drive Slip.
      b. S Slip.
      c. Reinforced Bar-S Slip.
      d. Pocket Joint.
      e. Flanged Systems (Ductmate®, MEZ, or equal) comprised of:
         1) Rolled flanges with integral mastic seals.
         2) Bolted preformed corner pieces.
         3) Sealing gaskets.
         4) Flange joint drive cleats.
   5. Sealing Requirements
      a. Class A – All transverse joints, longitudinal seams, and duct wall penetrations.
      b. Class B – All transverse joints and longitudinal seams.
      c. Class C – All transverse joints,except that all duct joints and longitudinal seams for all SMACNA classes of duct shall be sealed with U.L. listed Carlisle Hardcast DT-Tape and RTA-50 sealant.

B. Galvanized Steel Round or Oval Duct
   1. Single or double wall construction as indicated by application.
   2. Minimum 26 gauge sheet metal thickness
   3. Longitudinal seams complying with the following industry standards:
      a. Continuous interlocking spiral wound.
      b. Continuously seam welded.
      c. Butt seam welded.
      d. Gore locked seam.
   4. Transverse joints complying with the following industry standards:
      a. Pipe & fitting coupled slip joint with radial fasteners.
      b. Swedge sleeve.
      c. Welded flanged & gasketed.

C. Aluminum Duct
   1. Comply with Galvanized Steel Rectangular, Round, or Oval Duct requirements except for sheet metal thickness.
   2. Provide equivalent steel sheet metal thickness per SMACNA HVAC Duct Construction Standards, Metal and Flexible Section 1.12. Minimum 0.032 inch sheet metal thickness. Minimum 0.014" thick aluminum, snaplock construction for residential clothes dryer exhaust.

D. Flexible Round Duct
   1. Flexmaster Type 5M insulated or equal.
   2. Compliant with NFPA 90A & 90B
   3. U.L. 181 Class 1 listed

4. ASTM E96 Procedure A rated for 0.05 Perm
5. Interlocking spiral wire of galvanized steel or aluminum construction
6. Aluminum foil, fiberglass, & aluminized polyester trilaminate liner
7. Rated to 6 inches WG positive and 1 inches WG negative
8. Insulated with 1" thick fiberglass insulation meeting R4.2
9. Reinforced metalized outer vapor barrier

E. Double Wall Thermal Duct (Interior Applications)
1. Shop fabricated or factory prefabricated double wall duct systems consisting of continuous inner and outer wall metal duct sections with integral thermal insulation preinstalled in the annular space separating the inner and outer wall sections.
2. Reference Section 23 07 13 “HVAC Insulation”, or other applicable Division 23 Sections for specific insulation requirements by application.
3. Paintable outer surface suitable for use in aesthetically exposed applications.
4. Comply with requirements of Galvanized Steel Rectangular, Round, and Oval Duct as applicable.
5. Provide double wall systems complete with all fittings, taps, and accessories.

F. Double Wall Thermal Duct (Exterior Applications)
1. Acceptable Manufacturers: Thermaduct or other Engineer accepted manufacturer of an approved equal product.
2. General:
   a. The panel shall be manufactured of CFC-free closed cell rigid thermoset resin thermally bonded on both sides to a factory applied 0.001" (25 micron) aluminum foil facing reinforced with a fiberglass scrim. An added UV stable, 1000 micron high impact resistant titanium infused vinyl shall be factory bonded to the outer surfaces to provide a zero permeability water tight barrier.
   b. Ductwork shall be provided with vinyl cladding, bolted corner joints, rated for 6" W.C. of positive or negative pressure and comply with SMACNA Air Leakage Class 1 requirements. Joints and seams of vinyl cladding shall be heat or chemically welded together for a weather-tight seam per manufacturer’s recommendations.
3. Insulation: Closed cell phenolic foam with a closed cell content of >90%.
   a. Minimum Density: 3.5 pcf with a minimum compressive strength of 28 psi.
   b. Maximum Temperature: Continuous rating of 185 degrees F inside ducts or ambient temperature surrounding ducts.
   c. Maximum Thermal Conductivity: 0.13 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   d. Minimum R-value: 8.1
   e. Permeability: 0.00 perms maximum when tested according to ASTM E 96/E 96M, Procedure A.
   f. Antimicrobial Agent: Additive for antimicrobial shall not be used but instead, raw product must pass UL bacteria growth testing.
   g. Noise-Reduction Coefficient: 0.05 minimum when tested according to ASTM C 423, Mounting A.
   h. Required Markings: All interior duct liner shall bear UL label and other markings required by UL 181 on each full sheet of duct panel; UL ratings for internal closure materials.
4. Closure Materials:
   a. UV stable 1000 micron high impact resistant titanium infused vinyl.
      1) Factory manufactured seamless corners for zero perms.
      2) Cohesive bonded over-lap at corner seam covers for zero perms.
      3) Water resistant titanium infused welded vinyl seams.
      4) Mold and mildew resistant.

b. Polymeric Sealing System:
   1) Structural Membrane: Aluminum scrim with woven glass fiber with a laminated UV stable vinyl jacket.
   2) Minimum Seam Cover Width: 2-7/8".
   3) Sealant: Low VOC.
   4) Color: Standard White (other light reflective colors available).
   5) Water resistant.
   6) Mold and mildew resistant.

c. Duct Connectors.
   1) Factory manufactured cohesive bonded strips (low pressure only).
   2) Factory manufactured all aluminum grip flange.
      a) Grip flange
      b) F-flange
      c) H-flange
      d) U-flange
   3) Factory manufactured galvanized 4-bolt flange.

5. Outdoor Cladding: Duct segments shall incorporate UV stable 1000 micron high impact resistant titanium infused vinyl which is introduced during the manufacturing process.
6. Flange coverings
   1) Foam tape insulation with molded 1000 micron covers.
   2) Air gap (heating only application) with molded 1000 micron covers.

G. Double Wall Acoustical Duct
1. Shop fabricated or factory prefabricated double wall duct systems consisting of perforated inner and continuous outer wall metal duct sections with integral thermal acoustic insulation preinstalled in the annular space separating the inner and outer wall sections.
2. Provide inner duct with 3/32 inch diameter perforation holes staggered at 3/16 inch on center.
3. Reference Section 23 07 13 "HVAC Insulation" or other applicable Division 23 Sections for specific insulation requirements by application.
4. Paintable outer surface suitable for use in aesthetically exposed applications.
5. Conform to the requirements of galvanized steel rectangular, round, and oval duct as applicable.
6. Provide double wall systems complete with all fittings, taps, and accessories.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for pressures indicated.

B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No reduction of equivalent duct area is permitted except by reviewed shop drawings.

C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

D. Construct duct fittings per SMACNA standard details.
1. Provide typical supply, return and exhaust duct as detailed by SMACNA Section II fittings and other construction.

2. The interior surface of all duct shall be smooth. No sheet metal parts, tabs, angles, or anything else may project into the ducts for any reason, except as specified to be so. All seams and joints shall be external.
3. Provide 90 degree elbows constructed in accordance with SMACNA Figure 2-2, style RE-1 radius elbow (center line radius = 1.5 times duct height or width), space permitting; or style RE-2 square throat with turning vanes (provide duct access panel up stream of turning vanes for cleaning purposes) where required.
4. Where rectangular elbows are used, provide single thickness turning vanes in accordance with SMACNA Figure 2.3; single wall type with trailing edge for duct velocities up to 1500 fpm and double wall turning vanes above 1500 fpm duct velocity.
5. Provide parallel flow branches constructed in accordance with SMACNA Figure 2-7.
6. Provide expanded 45 degree entry type rectangular duct branch connections.
7. Provide spin-in type round branch duct connections in accordance with SMACNA Figure 2-8.
8. Provide offsets and transitions in accordance with SMACNA Figure 2-9.
9. Provide round spin-in fittings with locking quadrant volume dampers for all round duct connections to rectangular ducts. Spin-in and flex duct shall be same size as air distribution device neck diameter. Secure flex duct to spin-in and air distribution device neck with stainless steel worm gear clamps and seal vapor barrier. Suspend flex duct from structure above; round and flexible duct installations shall be as detailed by SMACNA in section III round, oval and flexible duct. Flexible duct supports shall be constructed and installed in accordance with SMACNA figures 3-9 and 3-10.
10. Duct access doors shall be constructed in accordance with figure 2-12 and shall have a frame type 3, position 3 hinge with a type 2 locking handle; single and multi-blade volume dampers shall be in accordance with figures 2-14 and 2-15 respectively and shall have operator extensions when provided on externally insulated ducts; air distribution device connections shall be in accordance with figure 2-16 and ceiling diffuser branch ducts shall be in accordance with figure 2-17.
11. Rectangular duct connections at all air moving equipment shall be flexible neoprene fabric and installed in accordance with figure 2-19.
12. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
13. All duct shall be fabricated in a manner to prevent the seams or joints being cut for the installation of air distribution devices.
14. Provide crimps in direction of air flow where crimp joints with bead are used for joining round duct sizes 6 inch smaller.

E. Where required, provide ducts with "ESS"-drive joints or flat seams to allow crossing of duct or installation of other equipment or piping requiring tight clearances. Raise ducts where required to allow installation of other duct or equipment using 45 degree radius elbows (center line radius = 1.5 times duct height) to offset.

F. Provide openings in duct where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal well and closure device to ensure against air leakage. Where openings are provided in insulated duct, install insulation material inside a metal ring.

G. Connect fan coil units to low pressure OA intake ducts with short length of flexible duct. Hold in place with corrosion resistant clamp or strap.

H. Connect air distribution devices to low pressure ducts with 6 feet maximum, 4 feet minimum, length of flexible duct. Hold in place with corrosion resistant strap or clamp.

I. All rectangular duct located exposed on roof shall have top horizontal surface "crowned or sloped" to prevent water from ponding.

3.2 DUCT APPLICATION SCHEDULE

A. Unless indicated otherwise, provide duct systems complying with the following application schedule:

AIR SYSTEM	CONSTRUCTION	MATERIAL	PRESSURE CLASS
Main Supply Above Ceiling or Concealed	Single Wall	Galvanized Steel	Per AHU ESP, 3" Class Minimum
Main Supply Exposed in Unoccupied Spaces	Single Wall	Galvanized Steel	Per AHU ESP, 3 " Class Minimum
Main Supply Exposed in Occupied Spaces	Double Wall	Galvanized Steel	Per AHU ESP, 3 " Class Minimum
Main Supply Exposed Exterior	Single Wall	Welded Carbon Steel	Per AHU ESP, 3 " Class Minimum
Downstream Supply Above Ceiling or Concealed	Single Wall	Galvanized Steel	Per Terminal ESP
Downstream Supply Exposed in Occupied Spaces	Double Wall	Galvanized Steel	Per Terminal ESP
Draw-thru Transfer, Return, or Relief	Single Wall	Galvanized Steel	1" Class
Pressurized Transfer, Return, or Relief	Single Wall	Galvanized Steel	Per Fan ESP
Draw-thru O/A Intake Above Ceiling or Concealed	Single Wall	Galvanized Steel	1" Class
Draw-thru O/A Intake Exposed in Occupied Spaces	Double Wall	Galvanized Steel	1" Class
Pressurized O/A Intake Above Ceiling or Concealed	Single Wall	Galvanized Steel	Per Fan ESP, 2" Class Minimum
Pressurized O/A Intake Exposed in Occupied Spaces	Double Wall	Galvanized Steel	Per Fan ESP, 2" Class Minimum
General Exhaust	Single Wall	Galvanized Steel	Per Fan ESP, 1" Class Minimum
Moist Air Exhaust (Shower Areas)	Single Wall	Aluminum	Per Fan ESP, 1" Class Minimum

3.3 DUCT HANGERS AND SUPPORTS

A. All duct shall be properly suspended or supported from the building structure.

B. The spacing, size and installation of hangers shall be in accordance with the recommendations of SMACNA, latest edition.

C. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Hangers shall be attached to the bottom of the duct.

D. Provide double nuts and lock washers on threaded rod supports

E. All duct shall be mounted tight to underside of structure and shall be top level with bottom and side transitions only, except that allowance shall be made for duct to be externally insulated, which shall be mounted 3" below structural beams and joists or other obstruction to allow installation of the external duct insulation.

F. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor. Secure floor supports to duct using rods, angles or flat bar to the duct joint or reinforcing. Provide miscellaneous steel supports for duct risers as required at no additional cost to Owner.

G. Where ducts pass through walls in exposed areas, provide framed openings constructed of welded metal angles. All angles shall be carried around all four sides of the duct or group of ducts.

3.4 ADJUSTING AND CLEANING

A. Clean duct system by vacuuming and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.5 TESTING

A. Pressure test ductwork per Quality Control requirements.

END OF SECTION 23 31 13

23 33 00
DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
a. Special fittings.
b. Manual volume damper installations.
c. Control damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

C. Comply with the 2015 edition of the International Energy Conservation Code (IECC) with City of Stafford, Texas amendments.

1.5 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

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 A653/A653M.
   1. Galvanized Coating Designation: G90 (Z275).
   2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed and exposed ducts.

D. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Greenheck Fan Corporation.

3. Nailor Industries Inc.
4. Pottorff; a division of PCI Industries, Inc.
5. Ruskin Company.
6. American Warming and Ventilating.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: 0.063-inch- thick extruded aluminum with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum noncombustible with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:
1. Material: Stainless steel.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Synthetic pivot bushings.

M. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
   a. Sleeve Thickness: 20-gage minimum.
   b. Sleeve Length: 6 inches minimum.
6. Screen Material: Aluminum.
7. Screen Type: Bird.
8. 90-degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Lloyd Industries, Inc.
5. Nailor Industries Inc.

6. Pottorff; a division of PCI Industries, Inc.
7. Ruskin Company.
8. American Warming and Ventilating.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch WG.

E. Frame: 0.063-inch thick extruded aluminum, with welded corners and mounting flange.

F. Blades:
1. Multiple, 0.025-inch-thick, roll-formed aluminum.
2. Maximum Width: 6 inches.
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

G. Blade Seals: Neoprene.

H. Blade Axles: Nonferrous metal.

I. Tie Bars and Brackets:
1. Material: Aluminum
2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Synthetic.

L. Accessories:
1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. McGill AirFlow LLC.
   d. METALAIRE, Inc.
   e. Nailor Industries Inc.
   f. Pottorff; a division of PCI Industries, Inc.
   g. Ruskin Company.
   h. Trox USA Inc.
   i. American Warming and Ventilating.
2. Standard leakage rating, with linkage outside air stream.
3. Suitable for horizontal or vertical applications.

4. Frames:
   a. Hat-shaped, galvanized channels, 0.064-inch minimum thickness.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized, 0.064 inch thick.
6. Blade Axles: Nonferrous metal.
7. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

2.5 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
   1. American Warming and Ventilating.
   2. Greenheck Fan Corporation.
   3. METALAIRE, Inc.
   4. Nailor Industries Inc.
   5. Pottorff; a division of PCI Industries, Inc.
   6. Prefco; Perfect Air Control, Inc.
   7. Ruskin Company.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum4000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside air stream fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

K. Furnish and install where shown on the drawings or required by the Specifications, fire dampers meeting the following requirements.

L. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555. All dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural drawings) protection rating, 165 or 212 degree F fusible link, and shall bear a U.L. label in accordance with Underwriters Laboratories labeling procedures. Fire dampers shall be constructed such that the damper frame material and the curtain material shall be galvanized.

M. Fire dampers shall be curtain blade or multi-blade type and the damper shall be so constructed that the blades are either out of the air stream or installed in an oversized sleeve to provide a 100 percent free area of the duct in which the damper is housed.

N. The damper manufacturer's literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500 Standards and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates. Maximum pressure drop through fire damper shall not exceed 0.05 inch water gauge.

O. Fire dampers shall be equipped for vertical or horizontal installation as required by the locations shown in the drawings. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles and other material and practices required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be a minimum of 1 1/2 inch by 1 1/2 inch by 14-gauge and bolted, tack welded or screwed to the sleeve at maximum spacings of 12 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the gauge of the duct defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6" water gauge static pressure.

P. The damper installation shall be in accordance with the damper manufacturer's instructions.

Q. All fire dampers shall comply with the Specification as written above and shall be Ruskin Model IBD2 (Style C, CR or CO), Greenheck Model FD-150 (Type C, CR or CO), or Pottorff.

R. The Contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.

S. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design airflow at the point of installation. The minimum closure pressure rating shall be 8" WG for airflow in either direction.

2.6 COMBINATION FIRE/SMOKE DAMPERS

A. Furnish and install where shown on the Drawings, or as required by the Specifications, combination fire/smoke dampers meeting the following requirements.

B. Each combination fire/smoke damper shall be 1-1/2 hour fire rated under UL Standard 555, 4th Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated

Damper for use in smoke control systems under the latest version of UL 555S, and bear a UL label attesting to same. The damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL 555S shall be no higher than Leakage Class I (4 cfm per square foot at one inch water gauge pressure and 8 cfm per square foot at 4 inches water gauge pressure). The maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10 inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.)

C. The damper frame shall be a minimum of 20-gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non-electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. The dampers may be either parallel or opposed blade type. The blades shall be constructed with a minimum of 14-gauge equivalent thickness. The blade edge seal material shall be able to withstand 450 degrees F. The jamb seals shall be flexible stainless steel compression type or lap seal type.

D. In addition to the leakage ratings specified herein, the combination fire/smoke dampers and their operators shall be qualified under UL 555S to an elevated temperature of 250 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. The damper and operator shall be supplied as a single entity which meets all applicable UL 555 and UL 555S qualifications for both dampers and operators. The manufacturer shall provide a factory assembled sleeve. The sleeve shall be a minimum of either 20-gauge for dampers where neither width nor height exceeds 48 inches or 16-gauge where either dimension equals or exceeds 48 inches.

E. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches water gauge in the closed position, and 2500 fpm air velocity in the open position.

F. Each combination fire/smoke damper shall be equipped with a UL Classified Firestat /releasing device. The firestat/releasing device shall electrically and mechanically lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. The damper must be operable while the temperature is above 250 degrees F. The actuator/operator package shall include two (2) damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations.

G. The damper releasing device shall be mounted within the airstream. The device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.

H. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated in the plans, and shall be furnished

and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor.

I. Each damper shall be furnished in a square or rectangular configuration. The Contractor shall furnish and install sleeves manufactured by the approved damper manufacturer for each damper. The sleeves shall be constructed with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturers U.L. installation instructions. The entire assembly, following installation, shall be capable of withstanding 6" W.G. static pressure.

J. All combination fire/smoke dampers shall comply with the specification as written above and shall be Ruskin Model FSD-60, Greenheck Model FSD-33, or Pottorff.

K. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.

L. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design air flow at the point of installation. The minimum closure pressure rating shall be 8” wg for air flow in either direction.

2.7 CEILING RADIATION DAMPERS

A. Galvanized steel multiple blade type with UL 555C testing and rating. Damper shall be same size as return or supply air opening. No part of damper shall be in the air stream.

B. Provide dampers as required to protect HVAC penetrations in the ceiling membrane portion of a fire rated floor/ceiling or roof/ceiling assembly.

C. Dampers shall have 165 degrees F reusable thermal link.

2.8 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Flexmaster U.S.A., Inc.
   3. Greenheck Fan Corporation.
   4. McGill AirFlow LLC.
   5. Nailor Industries Inc.
   6. Pottorff; a division of PCI Industries, Inc.
   7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
   1. Door:
      a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two (2) sash locks.
   b. Access Doors up to 18 Inches Square: Two (2) hinges and two (2) sash locks.
   c. Access Doors up to 24 by 48 Inches: Three (3) hinges and two (2) compression latches.
   d. Access Doors Larger Than 24 by 48 Inches: Four (4) hinges and two (2) compression latches with outside and inside handles.

C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 10-inch W.G.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch thick, fibrous-glass or polystyrene-foam board.

2.9 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.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch w.g. positive and 1.0-inch w.g. negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with IECC-2012.

C. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch w.g. positive and 1.0-inch w.g. negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 degrees F.
4. Insulation R-value: Comply with IECC-2012.

D. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches to suit duct size.
2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

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.

2.11 LOW PRESSURE TAPS (CONICAL BELL MOUTH FITTINGS)

A. Conical fittings may be used for duct taps and shall include quadrant dampers on all lines to air devices (diffusers and grilles), even though a volume damper is specified for the air device. (This does not apply to medium pressure duct.) Spin-in fittings shall be sealed at the duct tap with a gasket, or compression fit, or sealed with sealant specified for medium pressure ductwork. The location of spin-in fittings in the ducts shall be determined after dual or single duct terminal units are hung or the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends.

B. The conical fitting shall be made of at least 26-gauge galvanized sheet metal. The construction to be a two-piece fitting with a minimum overall length of 6 inches and shall be factory sealed for high pressure requirements. Average loss coefficient for sizes 6, 8, and 10 shall be less than 0.055.

C. Each to be provided with minimum 24-gauge damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper from rotating around shaft.

D. Provide flange and gasket with adhesive peel-back paper for ease of application. The fitting shall be further secured by sheet metal screws spaced evenly at no more than 4 inches on-center with a minimum of four screws per fitting.

E. The conical bellmouth fitting shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc., or Buckley Air Products, Inc., 'AIR-TITE'.

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.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

3.2 DAMPERS

A. Furnish and install dampers where shown on the Drawings and wherever necessary for complete control of the air flow, including all supply, return and exhaust branches, "division" in main supply, return and exhaust ducts, each individual air supply outlet and fresh air ducts. Where access to dampers through a fixed suspended ceiling is necessary, the Contractor shall be responsible for the proper location of the access doors.

B. Splitter dampers shall be fabricated of steel not lighter than 16-gauge. The leading edge of the damper shall be hemmed. Each splitter shall be a minimum of 12" long or 1-1/2 times the width of the smaller of the two branches it controls, whichever is greater. Dampers shall be carefully fitted, and shall be controlled by locking quadrants equal to Ventlok No. 555 on exposed uninsulated ductwork, No. 644 on exposed externally insulated ductwork and No. 677 (2-5/8" diameter) chromium plated cover plate for concealed ductwork not above lay-in accessible ceilings. Furnish and install end bearings for the damper rods on the end opposite the quadrant when No. 555 or No. 644 regulators are used, and on both ends when No. 677 regulators are used.

C. On concealed ductwork above lay-in accessible ceilings use Ventlok No. 555 or No. 644 locking quadrant for splitter dampers.

D. Dampers larger than three (3) square feet in area shall be controlled by means of rods hinged near the leading edge of the damper with provisions for firmly anchoring the rod and with end bearings supporting the axle.

E. Volume dampers shall be equal to those of American Foundry. Blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16-gauge galvanized steel supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating ferrule type.

F. Install all dampers furnished by the Temperature Control Manufacturer in strict accordance with the manufacturer's recommendations and requirements of these Specifications.

G. All adjustable dampers installed in externally insulated ductwork shall be installed with Ventlok No. 639, or equal, elevated dial operators. Insulation shall extend under the elevated dial. All adjustable dampers installed in internally insulated ductwork shall be installed with Ventlok No. 635, or equal, dial operators. All damper shaft penetrations in the ductwork shall be installed with Ventlok #609 end bearings.

H. 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.
   2. Install aluminum volume dampers in aluminum ducts.

I. Set dampers to fully open position before testing, adjusting, and balancing.

J. Install test holes at fan inlets and outlets and elsewhere as indicated.

K. Install fire dampers and ceiling radiation dampers according to UL listing.

L. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot spacing.
   8. Upstream and downstream from turning vanes.
   9. Upstream or downstream from duct silencers.
   10. Control devices requiring inspection.
   11. Elsewhere as indicated.

M. Install access doors with swing against duct static pressure.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

23 34 16
FANS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnish and install roof and wall exhausters and cabinet and ceiling exhaust fans for mechanical systems.

1.2 RELATED SECTIONS

A. Section 01 60 00 – Product Delivery, Storage and Handling Requirements.

B. Section 23 05 39 – Sleeves, Flashings, Supports And Anchors.

C. Section 23 05 48 – Vibration Isolation and Wind Controls for HVAC.

D. Section 23 31 13 – Metal Ducts.

E. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC.

F. Section 23 05 13 – Common Motor Requirements for HVAC.

1.3 REFERENCES

A. AMBA Method of Evaluating Load Ratings of Bearings ANSI-11 (r1999)

B. ANSI/AMCA 204-05, "Balance Quality and Vibration Levels for Fans"

C. ANSI/AMCA 210-07, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"

D. ANSI/AMCA 300-08, "Reverberant Room Method for Sound Testing of Fans"

E. ANSI/AMCA 301 – Method of Publishing Sound Ratings for Air Moving Devices.

F. ANSI/AMCA 500-D-12, "Laboratory Methods of Testing Dampers for Rating"

G. ANSI/AMCA 500-L-12, "Laboratory Methods of Testing Louvers for Rating"

H. ANSI/AMCA 99-10, "Standards Handbook”

I. ANSI/AMCA Publication 211-05, "Certified Ratings Program – Product Rating Manual for Fan Air Performance"

J. ANSI/AMCA Publication 311-05, "Certified Ratings Program – Product Rating Manual for Fan Sound Performance"

K. IBC 2015 – International Building Code

L. ICC-ES AC 156 – International Code Council Evaluation Services Acceptance Criteria 156

M. IMC 2015 – International Mechanical Code

N. OSHA guideline 1910.212 – General requirements for Machine Guarding. (www.osha.gov)

O. OSHA guideline 1910.219 – General requirements for guarding safe use of mechanical power transmission apparatus. (www.osha.gov)

P. OSHA guideline 1926.300 – General requirements for safe operation and maintenance of hand and power tools. (www.osha.gov)

Q. SMACNA – HVAC Low Pressure Duct Construction Standard -Metal and Flexible.

R. SMACNA - Medium Pressure Plenum Construction Standard

S. UL/cUL 705, Power Ventilators

1.4 SUBMITTALS

A. Include fan curves with specified operating point clearly plotted.

B. Include sound power levels for both fan inlet and outlet at rated capacity.

C. Indicate special coating when required.

D. Provide operation and maintenance manual.

E. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Performance Ratings: Conform to ANSI/AMCA Standards 210 and 300. Fans must be tested in accordance with AMCA Publications 211 and 311 in an AMCA accredited laboratory and certified for air and sound performance. Fan shall be licensed to bear the AMCA ratings seal for air performance (AMCA 210) and sound performance (AMCA 300). Manufacturers that are not licensed to bear the AMCA 210 ratings seal must provide performance witness testing (at the manufacturer's expense), per paragraph 1.4.D..

B. Classification for Spark Resistant Construction shall conform to ANSI/AMCA Standard 99.

C. Each fan shall be vibration tested before shipping, as an assembly, in accordance with ANSI/AMCA Standard 204. Each assembled fan shall be test run at the factory at the specified fan RPM and vibration signatures shall be taken on each bearing in three planes - horizontal, vertical, and axial. The maximum allowable fan vibration shall be less than 0.15 in. /sec peak velocity; filter-in reading as measured at the fan RPM. This report shall be provided at no charge to the customer upon request.

D. Manufacturer's that do not comply with paragraph 1.5.A must also provide, at the owner and engineer's option and manufacturer's expense, witness testing of fan discharge airflow, performed at an AMCA accredited laboratory, in accordance with AMCA 210. This test shall verify the critical and safety related performance of the high plume blower, as stated by the manufacturer.

E. Roof mounted fans shall have been analyzed and stamped by a State of Texas State licensed professional engineer to the ASCE 7-02 Standard which meets the IBC code. Wind-Restraint Loading is as follows:
   1. Ultimate Wind Speed: 147 mph, 3-second gust.
   2. Exposure: B.
   3. Risk Category: III.
   4. Minimum 10 lb/sq. ft. 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.

F. Roof mounted fans shall be certified by a third party to the ASTM E330 Static Pressure Difference Standard.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

B. Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage, follow manufacturer's Installation, Operation and Maintenance manual.

C. Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.7 WARRANTY

A. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

B. The warranty of this equipment is to be free from defects in material and workmanship for a period of 12 months from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the manufacturers' option when returned to the manufacturer, transportation prepaid.

C. Motor Warranty is warranted by the motor manufacturer for a period of one (1) year. Should motors furnished prove defective during this period, they should be returned to the nearest authorized motor service station.

1.8 MAINTENANCE

A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) months normal and preventive maintenance shall be included within this scope of work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Greenheck.

B. Cook.

C. Penn Barry

D. Acme

E. Twin City Fan

2.2 DIRECT DRIVE ROOF DOWNBLAST CENTRIFUGAL EXHAUST FANS

A. General Description:
1. Downblast fan shall be for roof mounted applications
2. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

B. Wheel:
1. Constructed of aluminum
2. Non-overloading, backward inclined centrifugal.
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05.
4. The wheel cone and fan inlet shall be matched and shall have precise running tolerances for maximum performance and operating efficiency.

C. Motors:
1. AC Induction Motor
   a. Motor enclosures: Totally enclosed fan cooled.
   b. Motors shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase for smaller fan sizes. Larger fan sizes shall use sleeve bearings.
   c. Mounted on vibration isolators, out of the airstream
   d. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants
   e. Accessible for maintenance.

D. Housing:
1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum
2. Shroud shall have an integral rolled bead.
3. Shroud shall be drawn from a disc and direct air downward.
4. Lower windband shall have a formed edge.
5. Motor cover shall be drawn from a disc.
6. All housing components shall have final thicknesses equal to or greater then preformed thickness.
7. Curb cap shall have pre-punched mounting holes to ensure correct attachment.
8. Rigid internal support structure.
9. Leak proof.

E. Housing Supports and Drive Frame:
1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators

F. Vibration Isolation:
1. Rubber isolators
2. Sized to match the weight of each fan

G. Disconnect Switches:
1. NEMA rated: 3R.

2. Positive electrical shut-off.
3. Wired from fan motor to junction box installed within motor compartment.

H. Accessories
1. 1. Birdscreen:
   a. Material Type: Aluminum
2. Roof Curbs:
   a. Mounted onto roof with fan
   b. Material: Aluminum.
   c. Insulation thickness: 1 inch.
   d. Coating Type: None.
3. Curb Extension
   a. Material Type: Aluminum.
   b. Coating: None.
4. Curb Seal:
   a. Rubber seal between the fan and the roof curb
5. Dampers:
   a. Type: Motorized.
   b. Balanced for minimal resistance to flow.
   c. Galvanized frames with pre-punched mounting holes.
6. Finishes:
   a. Types: None.
7. Hinge Kit:
   a. Aluminum hinges
8. Hinge Base:
   a. Aluminum hinges
   b. Hinges and restraint cables shall be mounted to a base (sleeve)
   c. Allows the fan to tilt away for access to wheel and ductwork for inspection and cleaning
9. Pressure Probe:
   a. ¼ inch diameter tube in the fan venturi that allows hook up to manometer
10. Tie-Down Points:
   a. Four (4) heavy gauge aluminum brackets to secure the fan in heavy wind applications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Secure roof exhausters with 1/2" x 2” S.S. lag screws roof curb.

C. Install flexible ductwork connections when fan connects to ductwork.

D. Provide al ventilating and exhaust fans with integral vibration isolation.

E. Water test ventilators after installation.

3.2 PAINTING

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 fans to allow service and maintenance.

C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.

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."

3.3 FIELD QUALITY CONTROL

A. Provide equipment with factory finish in accordance with the manufacturer's standards. Touch scratches and marks from handling and installation with masking enamel to match manufacturer's color.

B. Where exhaust fans are required to have Heresite coating, have units factory finished with required number of coats prior to shipping to the job site.

END OF SECTION 23 34 16

23 36 00
AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnish and install air terminal units of constant volume fan powered type for use in variable volume central systems, including:
   1. VAV terminal units.
   2. Variable volume regulators.
   3. Integral heating coils.
   4. Integral sound attenuator.
   5. Integral damper motor operators.
   6. Integral controls.

1.2 RELATED SECTIONS

A. Section 23 07 16 – HVAC Equipment Insulation.

B. Section 23 21 13 – Hydronic Piping.

C. Section 23 31 00 – Metal Ducts.

D. Section 23 33 00 – Air Duct Accessories.

E. Section 23 09 93 – Energy Management and Control System (EMCS).

F. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC.

G. Coordinate with Commissioning Requirements indicated in Section 017500. This Contractor is responsible to comply with all requirements for the above section.

1.3 REFERENCE STANDARDS

A. ADC 1062 – Air Distribution and Control Device Test Code.

B. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.

C. AHRI 880 - Performance Rating of Air Terminals.

D. AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

E. ASHRAE 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

F. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.

G. ASHRAE 130 - Methods of Testing for Rating Ducted Air Terminal Unit.

H. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

I. ASTM C1338 Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.

J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

K. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements.

L. IMC – International Mechanical Code, 2015 edition with City of Stafford, Texas amendments.

M. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

N. NFPA 70 - National Electrical Code, 2017 edition.

O. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association.

P. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

Q. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.

R. UL 1995 – Standards for Heating and Cooling Equipment.

1.4 CERTIFIED INDEPENDENT TESTING

A. Prior to providing Submittals, the unit manufacturer is required to submit one powered terminal unit of each size to be used on this project. Unit shall be shipped to the TAB Contractor for testing in their test facility.

B. Units found to be in compliance with specifications will be returned to unit manufacturer (at their expense) and may be submitted to the A/E for review.

C. Units not found to be in compliance with specifications will be returned to unit manufacturer (at their expense) for modification and/or re-design. All unit sizes will be re-tested by the TAB Contractor (at the expense of the unit manufacturer) until they are brought into total compliance with specifications.

1.5 SUBMITTALS

A. Indicate on product data the configuration, general assembly, and materials used in fabrication.

B. Include manufacturer's installation instructions.

C. Include certified factory test results indicating the noise criteria and sound power and performance characteristics for each unit. Include maximum and minimum cfm ratings at 0.50-inch WG with the unit on fully bypass or fully primary air with the fan running a medium speed, radiated sound power and discharge sound pressure with the fan on and unit on full bypass, fan horsepower and fan curve, pressure drop through the unit with heating coil and dampers on full bypass. Include schedules listing discharge and radiated sound power level for each of second through sixth octave band at inlet static pressures on 1 to 4 inch WG.

D. Provide operation and maintenance manual. Include directions for resetting constant volume generator.

E. A sample 8-inch size production run unit shall be submitted for examination and approval by the Engineer, and the Owner's Testing and Balancing (TAB) Consultant. This submittal box shall be submitted, in addition to the required written submittal, well in advance of any requirement for installation of boxes, but absolutely no later than 60 days after the date of the start of construction stipulated in the Work Order letter from the Owner to the General Contractor. A minimum of three (3) weeks shall be allowed by the Contractor for the testing of the box from the time of submittal to the time of determination of project worthiness. This period shall restart if the sample box is rejected and another box is resubmitted. If rejected for any reason, the Contractor shall expedite the corrections documented, and shall resubmit a sample box as soon as possible. Any delay in the submittal of the box for approval shall not be grounds for a claim of delay on the part of the Contractor. If approved, the unit shall remain in the possession of the Owner at the job site for comparison with units as shipped to project. The unit shall be installed in the project, at an accessible, marked location. The unit Manufacturer shall test and certify that each box used on this project has been tested as specified.

1.6 MAINTENANCE

A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Titus.

B. Nailor.

C. Kruger.

D. Price Industries.

E. Trane.

F. Metalaire.

2.2 MANUFACTURED UNITS

A. The Contractor shall furnish and install pressure independent single duct series fan powered variable air volume control assemblies with integral attenuator (single duct units), of the sizes, capacities and configurations shown on the Drawings.

B. Identify each airflow unit with clearly marked identification label and airflow indicator. Include unit nominal air flow, maximum factory set air flow, minimum factory set air flow, and coil type on label.

C. Basis of design is Price Industries, Inc. Constant-Volume Series Fan-Powered Unit (Model FDCA-2 with direct digital controls). Even though specific manufacturers may be named herein, the material supplied by any approved manufacturer shall meet all of the provisions of this specification without exception. All terminal units shall be provided with unit mounted transformers for fan motor and for controls as required and all protection devices per NEC requirements for a single point electrical connection.

2.3 FABRICATION

A. Unit Casing: Minimum 22 gauge galvanized casing with 20 gauge bottom for sizes 6 to 8 and minimum 20 gauge casing with 18 gauge bottom for sizes 10 and above. Provide stiffeners and construct with sufficient rigidity to prevent vibration due to the action of turbulent air on the panel of the cabinet. Provide entire assembly capable of withstanding a maximum static pressure of 3.0 inches W.G. Units shall have full or divided removable bottom access panels with quarter-turn mechanical locks. Unit casing shall all incorporate a minimum of four (one at each corner) galvanized steel angle brackets to accept minimum 1/2" diameter all-thread rod and vibration isolator. Brackets shall be located as required to allow removal of ductwork, heating coil and air filter without removing unit and shall be a minimum of 1" above bottom of unit casing.

B. Lining: EPFI Engineered Polymer Foam Insulation Liner , NFPA 90A, 1 inch thick, 1.5 pounds per cubic foot density, R-value of 4.0 with lining on interior surface exposed to air flow, and UL 181 erosion requirements. The insulation shall be secured with adhesive. Cover all exposed parts, such as braces, etc. in contact with exterior surfaces, to prevent condensation on the exterior of the cabinet and minimize both heat and sound transmission.

C. Assembly: Air volume damper and controls in single cabinet including inlet sound attenuator and renewable media filter in permanent frame.

D. Plenum Air Inlets: Round/Oval stub connections for standard size flexible duct attachment.

E. Air Outlets: Suitable for S and drive connections or 1 inch flanged duct attachment.

F. Limit air leakage from cabinet to a maximum of three percent (3%) at 3.0 inches W.G. interior casing pressure.

2.4 PRIMARY AIR VOLUME DAMPER ASSEMBLY

A. Locate primary air volume damper assembly inside unit casing. Construct from extrude aluminum or 20 gage galvanized steel components. Key damper blades into solid shaft rotating in bushings with nylon fitted pivot points. Secure damper to independent damper rod with a minimum of four (4) screws. Tap damper rod to allow the set screw of the control arm to penetrate the damper rod.

B. The low leakage 18 gauge damper assembly shall incorporate a peripheral gasket on the damper blades for tight airflow shutoff.
   1. Air leakage past the closed damper shall not exceed two percent of the unit maximum airflow at 3 inch water gauge inlet static pressure, tested in accordance with ASHRAE 130.
   2. The damper, seal and bushing system shall be tested to 1.25 million cycles, or the equivalent of 100 full open/closures per day for 35 years, with no visible signs of wear, tear, or failure of the damper assembly after such testing.

C. Airflow Sensor:
   1. The airflow sensor shall be a differential pressure airflow device measuring total and static pressure, and shall be mounted to the inlet valve.
   2. Plastic parts shall be fire-resistant, complying with UL 94.
   3. The airflow sensor shall be RoHS (Restriction of Hazardous Substances) compliant. Materials containing polybrominated compounds shall not be acceptable.
   4. Control tubing shall be protected by grommets at the wall of the airflow sensor's housing.

5. The airflow sensor shall be furnished with a minimum of twelve total pressure sensing ports and four static sensing ports, and shall include a center averaging chamber that amplifies the sensed airflow signal.
6. The airflow sensor signal accuracy shall be plus or minus five percent (5%) throughout terminal operating range.

D. Inlet Valve:
1. The inlet valve shall be a consistent diameter to retain flex duct and provide a stop for hard duct.
2. The inlet valve shall include a 1/8 inch raised single bead weld for added strength.
3. The gasket seal shall be a low leakage continuous piece with a peripheral gasket for tight airflow shutoff.
4. The inlet valve shall include two (2) heavy duty stop pins to accurately position the damper in the open and closed position.

E. Provide automatic flow control assembly which combines spring rates matched for each volume regulator size with machined dashpot for stable operation.

F. Mount automatic flow control assembly externally or provide access doors.

G. Provide factory calibrated assembly consisting of damper and damper shaft extension for connection to externally mounted control actuator.

H. Provide externally mounted electronic actuator to position damper, normally open, as indicated.

2.5 FAN ASSEMBLY

A. Forward curved centrifugal type fan of metal construction. Motors must be GE ECM, DC and brushless. Motor must be complete with and operated by a single phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically comminuted the stator. All motors must be designed for synchronous rotation. Motor rotor must be permanent magnet type with near zero rotor losses. Motor must have built in soft start and soft speed change ramps. Motor must be able to be mounted with shaft in horizontal or vertical orientation. Motor must be permanently lubricated with ball bearings. Sleeve bearings will not be acceptable. Motor shall be direct coupled to the blower. Motor must maintain a minimum of 70% efficiency over its entire operating range.

B. The manufacturer of the terminal units must set the fan cfm at the factory. Fan cfm must be constant within +/-5% regardless of changes in static whether upstream or downstream of the terminal unit after it is installed. Fan cfm is to be set with a potentiometer. Neither SCRs nor rheostats are acceptable means of setting fan cfm. A speed adjustment device must be included with the motor for field adjustment should construction or design changes become necessary.

C. Provide backdraft damper at the return air inlet to prevent backflow of primary air.

D. Internally suspend and isolate fan/motor assembly from casing on rubber isolator to prevent noise and vibration transmission from the fan/motor assembly to the casing.

E. Provide fan/ motor assembly with a service life of 15 years.

F. Provide capacitor or controls to allow rotation of the fan only in the proper direction regardless of condition of fan at start up.

G. Provide non-overloading type system with fan/motor assembly sized to supply all downstream static pressure requirements.

2.6 ELECTRIC HEATING COILS

A. Electrical heating coils installed in conjunction with single duct terminal units shall be factory installed, heating element shall be Nickel chrome complete with auto reset thermal cut outs, magnetic contactors, airflow safety switches, control transformer for automatic controls and fan relay for fan terminal. Provide at least SCR control for the heating coils.

B. Provide terminal bolts, nuts, and washers or corrosion resistant materials. Construct coil so installation may be accomplished in accordance with provisions of NFPA 70 for zero clearance. Coil to be given 2,000 volts dielectric test

C. Provide automatic reset thermal cutouts for primary protection with heat limiters in power circuits for secondary protection. Provide capability to service both devices through terminal box without removing heating element from unit.

D. Provide heater with UL listed dust tight cover, terminal box thermally insulated with built-in step controlled contactors for each circuit, branch circuit fusing or each 48 ampere circuit meeting requirements of NFPA 70, and static pressure air switch for installation in heater control enclosure. Provide quite acting magnetic type contactors. Provide separate 120 volt fused control power transformer with disconnect.

E. Heating coil shall be installed integral to unit housing with access doors and removable panels to allow removal of heating coil without disconnecting any ductwork from the terminal unit (No Exceptions). Heating coil section shall be insulated with the same insulation as the unit casing, as indicated above

2.7 WIRING

A. Factory mounted and wire controls. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.

B. Factory mount transformer for control voltage on electric and electronic control units. Provide terminal strip in control box for field wiring of thermostat and power source.

C. Provide factory installed fused disconnect switch.

2.8 CONTROLS

A. Automatic Damper Operator:
   1. Operate: Air volume damper and automatic volume control.
   2. Electric Damper Operator: 24 volt (normally closed).
   3. Maximum Volume Controller and Probe: Electronic, with calibration pressure taps for high flow limited proportional variable air volume control.
      a. Velocity Reset Controller and Probe: Electronic, with calibration pressure taps for pressure independent proportional variable air volume with means for pressure independent compensating for varying inlet static pressure, with minimum and maximum limits set at reset device, mounted in control box.

2.9 UNIT CONTROLS

A. Contain in NEMA-1 enclosure with access panel sealed from air flow and mounted on side of unit. The Terminal Equipment Controllers (TEC) shall be furnished by the Energy Management and Control System (EMCS) manufacturer to the unit manufacturer for installation, wiring and testing at their factory. The factory mounted controls shall accomplish the following specified Sequence of Operation.

B. Electronic Control Occupied Mode:
   1. When duct pressure is sensed indicating primary air system operating, and primary variable volume damper proportions air flow from EMCS.
   2. As space sensors senses reduced cooling demand, volume damper starts to move to factory set minimum volume. As cooling demand continues to fall, volume damper goes to minimum position.
   3. Velocity reset primary air control (pressure independent) with maximum and minimum limits.
   4. Hi-limit device, factory set, limits maximum primary air flow.
   5. As space sensor calls for less cooling, control system closes volume damper to minimum stop from central system primary air duct before heating is initiated. On sensing further need for heat, heating coil is energized.

C. Electronic Control – Unoccupied Mode
   1. DDC Control System cycles controls at reduced temperature (day / night setback).

2.10 SOUND ATTENUATOR

A. The manufacturer shall provide a close-coupled sound attenuator, as required, to meet scheduled acoustical performance requirements.

B. Attenuators shall be the following configuration (select all that apply):
   1. Inlet Attenuator
   2. Discharge Attenuator (DAS): Three foot discharge attenuator (DAS3).

2.11 SOUND PERFORMANCE CRITERIA

A. The following chart reflects maximum allowable discharge and radiated sound power level

Unit Size	Inlet Dia.	Fan and 100% Primary CFM	Maximum Radiated Sound Power Level, dB, at Band No. and Center Freq., Hz					
			2 125	3 250	4 500	5 1,000	6 2,000	7 4,000
	6	50 to 250	56	52	45	37	33	31
	8	251 to 500	55	50	45	38	34	33
	10	501 to 800	57	49	46	39	35	32
	12	801 to 1,150	63	56	53	45	41	40
	12	1,151 to 1,400	61	56	50	43	38	36
	14	1,401 to 1,600	67	60	53	46	43	42
	16	1,601 to 2,050	68	61	55	49	45	44
Unit Size	Inlet Dia.	Fan and 100% Primary CFM	Maximum Discharge Sound Power Level, dB, at Band No. and Center Freq., Hz					
			2 125	3 250	4 500	5 1,000	6 2,000	7 4,000
	6	50 to 250	66	60	54	49	45	40
	8	251 to 500	65	60	55	50	47	44
	10	501 to 800	66	57	57	54	50	49
	12	801 to 1,150	74	64	64	63	59	59
	12	1,151 to 1,400	70	63	62	62	58	58
	14	1,401 to 1,600	72	65	66	66	62	60
	16	1,601 to 2,050	74	67	68	69	66	65

Note: All ratings at 1.0″ wc Inlet Static Pressure and 0.5″ wc Discharge Static Pressure
Up to +2dB variation allowed.
Based Upon PRICE FDC2 Constant Volume with ECM (for Extended Range Operation)

2.12 TESTING PRIOR TO INSTALLATION:

A. Shipment Testing: A minimum of ten percent (10%) of each size of the terminal units (but no less than one unit of each size used) may be tested for conformance to this specification, at the Owner's discretion. The Contractor shall allow sufficient time during construction and space for the Owner's TAB Consultant to perform all testing as may be required.

B. Unit Non-Performance:

1. If the results of the SHIPMENT TESTING show that any of the units do not perform as specified, then an additional ten percent (10%) of each size (but no less than one unit of a size, unless 100% of the size has been tested) of the units shall be tested. If this testing, in the Owner's opinion, shows that ten percent (10%) or more of the units tested do not perform as specified, then one hundred percent (100%) of all sizes of the units shall be tested for conformance with these specifications. The results of that testing shall be reviewed carefully between the Contractor, Manufacturer, the Owner's construction

administrator(s), and the Owner's design engineer(s). A method of repair or replacing the units will be negotiated. The Owner, however, shall maintain the right of final approval of any proposed solution.

2. Should for any reason the testing described above under "SUBMITTAL" and "SHIPMENT TESTING" prove that any of the units do not perform as specified, the Contractor shall be responsible for all subsequent labor, travel, travel expenses, and incidental expenses, penalties, or other costs attendant to any additional testing as described under "UNIT NON-PERFORMANCE", or as required to prove that the units perform as specified. This shall include, but not be limited to, the labor, travel and reasonable incidental expenses of not only the Contractor and Owner's TAB Consultant, but also those incurred by the Owner as may be specifically required for this purpose. The expenses to be reimbursed to the Owner shall be labor at a rate of $300 per day or any portion of a day, plus travel and travel expenses at actual cost, plus reasonable incidental expenses at actual cost.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditions are suitable for installation.

B. Verify that field measurements are as shown on the Drawings.

3.2 INSTALLATION

A. Install the terminal units in accordance with manufacturer's instructions.

B. Install the inlets of the air terminal units with the air flow sensors a minimum of three (3) duct diameters from elbows, transitions, and duct takeoffs.

C. See Drawings for the size(s) and duct location(s) of the air terminal units.

D. Support the terminal units individually from the structure in accordance with manufacturer's recommendations.

E. Embed anchors in concrete in accordance with ASTM E488/E488M.

F. Do not support the terminal units from the ductwork.

G. Connect the terminals to the ductwork in accordance with Section 23 31 00.

H. Install heating coils in accordance with Section 23 82 00.

I. Verify that electric power is available and of the correct characteristics.

J. Provide ceiling access doors or locate units above easily removable ceiling components.
   1. Support units individually from building structure. Do not support from adjacent ductwork. (No Exceptions.)
   2. Refer to Section 23 31 13 for duct connections to equipment.
   3. Install heating coils in accordance with detail on Drawings.
   4. Install disposable filters in accordance with Section 23 41 00.

3.3 ADJUSTING

A. Ensure the damper operator attached to the assembly allows full modulation of flow range from 100 percent of design flow to zero.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional quality requirements.

3.5 CLEANING

A. See Section 01 74 19 - Construction Waste Management and Disposal for additional cleaning requirements.

END OF SECTION 23 36 00

23 37 00
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Diffusers.

B. Diffuser boots.

C. Registers/grilles.

D. Door grilles.

E. Louvers.

F. Louvered penthouse gravity ventilators.

1.2 RELATED WORK

A. Division 08 – Openings: Door Louvers.

B. Division 09 – Painting: Painting of Ductwork Visible Behind Outlets and Inlets.

C. Division 10 – Specialties: Metal Wall Louvers.

D. Section 23 00 00 – Basic Mechanical Requirements.

E. Section 23 31 00 – Ductwork.

F. Section 23 33 00 – Ductwork Accessories.

1.3 REFERENCES

A. ADC 1062 - Certification, Rating and Test Manual.

B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.

C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

D. AHRI 650 - Air Outlets and Inlets.

E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

F. SMACNA - Low Pressure Duct Construction Standard.

1.4 QUALITY ASSURANCE

A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate performance of louvers in accordance with AMCA 500.

1.5 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

1.6 SUBMITTALS

A. Submit product data under provisions of Division 01.

B. Provide product data for items required for this project.

C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.

D. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

E. Submit manufacturer's installation instructions under provisions of Division 01.

PART 2 - PRODUCTS

2.1 AIR SUPPLIES AND RETURNS

A. Grilles, registers and ceiling outlets shall be as scheduled on the Drawings and shall be provided with sponge rubber or soft felt gaskets. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five foot occupancy zone will be not more than 50 FPM nor less than 25 FPM. Noise levels shall not exceed those published in the ASHRAE Guide for the type of space being served (NC level). Grilles, registers and ceiling outlets shall be Titus, Krueger or Metalaire.

B. Locations of outlets on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures or architectural reflected ceiling plan. Where called for on the schedules, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual damper. These shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.

2.2 ACCEPTABLE MANUFACTURERS - CEILING DIFFUSERS

A. Titus.

A. Krueger.

B. Metalaire.

C. Price.

D. Substitutions: Under provisions of Division 01.

2.3 RECTANGULAR CEILING DIFFUSERS

A. Rectangular, stamped, multicore type all aluminum diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated; Model OMNI-AA manufactured by Titus.

A. Provide mounting frame to accommodate installation in ceiling types shown on the Drawings.

B. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

C. The face panel shall be removable by means of four (4) hanger brackets. The exposed surface of the face panel shall be smooth, flat, and free of visible fasteners. The face panel shall project 1/4 inch below the outside border of the diffuser backpan. Panels projecting more than 1/4 inch below the outside border are not acceptable.

D. The back of the face panel shall have an aerodynamically shaped, rolled edge to ensure a tight horizontal discharge pattern. A single metal thickness on the edges of the face panel will not be accepted. Ceiling diffusers with a 24 x 24-inch full face shall have no less than an 18 x 18-inch face panel size. Ceiling diffusers with a 12 x 12-inch full face shall have no less than a 9 x 9-inch face panel size.

E. The backpan shall be one (1) piece precision die-stamped and shall include an integrally drawn inlet (welded-in inlets and corner joints are not acceptable). The diffuser backpan shall be constructed of 22-gauge aluminum. The diffuser neck shall have a minimum of 1¼-inch depth available for duct connection.

F. Provide round volume damper and multi-louvered equalizing grid with damper adjustable from diffuser face. Optional round damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the diffuser.

G. Provide directional blow clips as required to restrict the discharge air in certain directions where shown on the Drawings.

H. Provide R-6, foil-backed molded insulation blanket with 1-inch gap around the neck to install insulated flex duct.

2.4 HIGH CAPACITY SQUARE, RECTANGULAR OR ROUND NECK CEILING DIFFUSERS

A. Ceiling diffusers shall be TITUS Model TDC (aluminum) for fixed, horizontal discharge pattern. These diffusers shall consist of an outer frame assembly of the sizes and mounting types shown on the plans and outlet schedule. A square or rectangular inlet shall be an integral part of the frame assembly and a transition piece shall be available to facilitate attachment of round duct. An inner core assembly consisting of fixed deflection louvers shall be available in one-, two-, three- or four-way horizontal discharge patterns. The inner core assembly must be removable in the field without tools for easy installation, cleaning or damper adjustment.

B. The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H.

C. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

D. Damper shall be constructed of heavy gauge aluminum. Damper must be operable from the face of the diffuser by removing the spring loaded inner core assembly. Throw Reducing Vanes

(TRV) must be available to deflect a horizontal discharge airstream from each side of the TDC diffuser into diverging airstreams.

E. The manufacturer shall provide published performance data for the diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70--2006 (RA 2011).

2.5 ACCEPTABLE MANUFACTURERS - CEILING REGISTERS/GRILLES

A. Titus.

B. Krueger.

C. Metalaire.

D. Price.

E. Substitutions: Under provisions of Division 01.

2.6 CEILING GRID CORE RETURN REGISTERS/GRILLES

A. Fixed grilles of 1/2 x 1/2 x 1/2 inch aluminum grid; Model 45F manufactured by Titus.

B. Grilles must prevent line of sight when viewed directly from the face and provide a free area perpendicular to the 45 degree openings of at least 90%.

C. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040-0.050 inch and shall have countersunk screw holes. Border width shall be 1¼ inches on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame.

D. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

2.7 CEILING GRID CORE EXHAUST REGISTERS/GRILLES

A. Fixed grilles of 1/2 x 1/2 x 1/2 inch aluminum grid; Model 50F manufactured by Titus.

B. Grilles must provide a free area of at least 90%.

C. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040-0.050 inch and shall have countersunk screw holes. Border width shall be 1¼ inches on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame.

D. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

E. Where not individually connected to exhaust fans, provide integral, gang-operated opposed blade dampers constructed of heavy gauge aluminum with removable key operator, operable from face.

2.8 ACCEPTABLE MANUFACTURERS - WALL REGISTERS/GRILLES

A. Titus.

B. Krueger.

C. Metalaire.

D. Price.

E. Substitutions: Under provisions of Division 01.

2.9 WALL SUPPLY REGISTERS/GRILLES

A. Streamlined and individually adjustable blades, 3/4 inch spacing with spring or other device to set blades, horizontal face, double deflection; Model 272FL manufactured by Titus.

B. Fabricate 1 inch margin frame with concealed mounting and gasket.

C. Fabricate of aluminum with 20 gauge minimum frames and 22 gauge minimum blades, aluminum with 20 gauge minimum frame, or aluminum extrusions, with factory baked enamel finish.

D. Front blades shall be parallel to the long dimension. Blades shall be constructed of heavy duty aluminum and shall be contoured to a specifically designed airfoil cross-section to meet published performance data. Hollow blades are not acceptable. Blades must be solid. Blades shall be spaced 3/4-inch apart. Blades shall extend completely through the side frame on each side to ensure stability throughout the complete cfm operating range of the grille. Blades shall be individually adjustable without loosening or rattling and shall be securely held in place with tension wire.

E. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

F. Provide integral, gang-operated opposed blade dampers constructed of heavy gauge aluminum with removable key operator, operable from face.

2.10 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Streamlined blades, depth of which exceeds 3/4 inch spacing parallel to the long dimension, with spring or other device to set blades, as scheduled; Model 350F manufactured by Titus.

B. Fabricate 1-1/4 inch margin frame with concealed mounting. Minimum border thickness shall be 0.040-0.050 inch.

C. Fabricate of aluminum with 20 gauge minimum frames and 22 gauge minimum blades, aluminum with 20 gauge minimum frame, or aluminum extrusions, with factory baked enamel finish.

B. Corners shall be welded with full penetration resistance welds. Sizes larger than 24 x 24 inches shall be constructed by using heavy aluminum extrusions and shall be interlocked at the four

corners and mechanically staked to form a rigid frame. Screw holes shall be counter-sunk for a neat appearance.

C. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed in place by crimping or welding. Blade deflection angle shall be set at 35°.

D. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

E. Where not individually connected to exhaust fans, provide integral, gang-operated opposed blade dampers constructed of heavy gauge aluminum with removable key operator, operable from face.

F. In gymnasiums, blades shall be front pivoted, welded in place, or securely fastened to be immobile.

2.11 ACCEPTABLE MANUFACTURERS - LOUVERS

A. American Warming and Ventilating.

B. Greenheck.

C. Arrow United Industries.

D. Ruskin.

E. Substitutions: Under provisions of Division 01.

2.12 LOUVERS

A. Acceptable Product: Model EME6325D as manufactured by Ruskin Company or Engineer accepted equivalent.

B. Listings:
1. AMCA 540 Level E and AMCA 550 Listing with the Air Movement and Control Association Certified Ratings Program.
2. Miami-Dade Acceptance Number: 15-0731.07.
3. Florida Notice of Acceptance Number: FL 14156.1.

C. Fabrication:
1. Design: Extruded aluminum, stationary louvers with horizontally mounted drainable blades.
2. Application: Miami-Dade Approved Product for use in open structures or installations where the enclosed space is designed to accommodate water infiltration (wet rooms). Miami-Dade County Protocols Compliance:
   a. TAS-202 Uniform Static Air Pressure Test.
   b. TAS-203 Cyclic Wind Pressure Test – Maximum Design Pressure Rating +/- 120 psf.
3. Frame:
   a. Frame Depth: 6 inches, nominal.
   b. Wall Thickness: 0.095 inch, nominal.

c. Material: Extruded aluminum, Alloy 6063-T6.

4. Blades:
   a. Style: Vertically mounted.
   b. Wall Thickness: 0.062 inch, nominal.
   c. Material: Extruded aluminum, Alloy 6063-T6.
5. Sill: Sill Flashing: Formed aluminum, 0.080 inch, upturned sides to prevent water leakage.

D. Performance Data:
1. Performance Ratings: AMCA licensed.
   a. Based on testing 48 inches x 48 inches size unit in accordance with AMCA 500-L.
2. Free Area: 42 percent, nominal.
3. Free Area Size: 6.66 square feet.
4. Maximum Recommended Air Flow through Free Area: 2,155 feet per minute.
5. Air Flow: 10,431 cubic feet per minute.
6. Maximum Pressure Drop (Intake): 0.60 inches w.g.
7. Water Penetration: Beginning point of water penetration of 0.01 ounce per ft² of free area shall be above 1,250 feet per minute free area velocity.
8. Wind Load Rating: Maximum wind load of ±150 PSF.
9. AMCA 500-L Wind Driven Rain Performance: 99.9 percent effective at preventing water penetration through louver when tested at 50 miles per hour wind with 8 inches per hour rainfall and 2,155 feet per minute airflow through the free area. Penetration Class ‘A’ with Discharge Class (Intake) ‘3’ in accordance with AMCA 500-L Wind Driven Rain Test.

E. Design Wind Criteria
1. Ultimate Wind Speed: 147 mph, 3-second gust
2. Exposure: B
3. Risk Category: III.

2.13 LOUVERED PENTHOUSE GRAVITY VENTILATOR

A. Extruded Aluminum Tiered Louver Ventilator: Welded, all aluminum construction meeting the following minimum construction requirements:
1. Frame: Heavy gauge extruded 6063-T5 aluminum, 6 in. x 0.081 in. nominal wall thickness
2. Blades: Horizontal rain resistant design, heavy gauge extruded 6063-T5 aluminum, 0.081 in. nominal wall thickness, positioned on approximately 2 in. centers
3. Construction: Welded and mechanically fastened.
4. Birdscreen: 3/4 in. x 0.051 fattened expanded aluminum removable frame, inside mount (rear).
5. Finish: Mill.

B. Assembly shall be tested in accordance with and pass TAS 202 (Uniform Static Air Pressure) and TAS 203 (Cyclic Wind-Loading).

C. Mount on minimum 8" high factory fabricated galvanized steel curb with 1/4" x 2" sponge rubber pad at mounting surface and 2" thick fiberglass insulation board.

D. Acceptable Product: Greenheck Model EHH-601PD or Engineer accepted equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturers' instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to Division 09.

C. Install diffusers to ductwork with airtight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Division 09.

F. All louvers located above ceilings are to have sheet metal plenums. Plenums are to be welded or soldered and shall be watertight. Plenum bottoms also shall slope to louver and the connection to the louver shall be watertight.

G. Secure all roof mounted equipment to the structure adequately to resist overturning, uplift and sliding forces for the following wind design criteria:
   1. Ultimate Wind Speed: 147 mph, 3-second gust.
   2. Exposure: B.
   3. Risk Category: III.

END OF SECTION 23 37 00

23 41 00
FILTERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Disposable media filters.

B. Filter frames.

C. Filter gauges.

1.2 RELATED SECTIONS

A. Section 23 74 16.13 – Packaged, Large-Capacity, Rooftop Air-Conditioning Units.

B. Section 233100 – HVAC Ducts and Casings.

C. Section 233600 – Air Terminal Units.

1.3 REFERENCES

A. UL 900 – Test Performance of Air Filter Units.

B. ASHRAE 52 – Method of Testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter.

1.4 SUBMITTALS

A. Include filter media, filter performance data, filter assembly and filter frames.

B. Provide Operation and Maintenance manual.

1.5 QUALITY ASSURANCE

A. Provide filter media that is UL 900 listed, Class 2, as approved by local authorities.

B. Provide all filters as product of one manufacturer.

C. Assemble filter components to form filter banks from products of one manufacturer.

1.6 EXTRA MATERIALS

A. Provide one (1) spare set of disposable media filters at project final acceptance for each piece of equipment requiring filters.

1.7 MAINTENANCE

A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been run tested under observation. During construction, if the air units operate at any time, minimum MERV 13 filters shall be installed and kept clean.

B. Provide two (2) sets of belts and three (3) sets of filters for each unit. One (1) set of filters to be installed when unit is started up and shall be protected from construction debris with additional media either at the first bank of filters or covering each air intake (outside air and return air). Second set of filters to be installed when test and balance activities begin. At substantial completion shall inspect filters to determine if the third set should be installed or delivered to school operations personnel. Tag to identify associated unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. American Air Filter.

B. Cam-Farr.

C. Continental.

2.2 PANEL FILTERS

A. All air filters shall be listed as (Class 1, Class 2) in accordance with Underwriters Laboratories, Inc., Building Materials Directory requirements, shall be manufactured of materials that are so listed by UL. All filters other than the ultrahigh efficiency type are to be rated in accordance with ASHRAE Test Standard 52-76 and performance characteristics are to be published in the manufacturer's literature. When specified performance characteristics are not published in the manufacturer's literature, the submittal data shall include certified documentation of performance by an approved independent test laboratory.

B. Permanent, Washable: Viscous coated, high velocity filters. The net velocity through the filters shall not exceed 500 fpm. Filters shall be 2" (two inches) thick and the initial clean resistance to air flow shall not exceed 0.10" (one tenth inch) W.G. Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles. Furnish one (1) complete set of spare filters for each system.

C. Sectional, Renewable Media: Air filters shall be 2" (two inches) thick adhesive coated glass fiber media pads enclosed in sectional frames of not less than 16 (sixteen) gauge galvanized steel and equipped with a quick opening mechanism for changing filter media. The airflow capacity of the filters shall be based on a net filter face velocity not exceeding 350' (three hundred and fifty feet) per minute with an initial resistance no greater than 0.10" (one tenth inch) water gauge. When used as pre-filters, and mounted in the same holding frames as higher efficiency secondary air filters, the airflow capacity may be based on 500' per minute with an initial resistance not to exceed 0.17" water gauge. Filters shall have an average arrestance of not less than 70 to 75% when tested in accordance with ASHRAE Test Standard 52.

D. Replaceable, Dry Type, Moderate Efficiency: Filters shall be of the pleated media, disposable type, 2" (two inches) deep in direction of airflow, Class 1 MERV 8. Each filter cell shall utilize a nonwoven, lofted cotton media with a net effective area of not less than 7.0 square feet of media per 1.0 square feet of filter face area, a media support grid, and enclosing high wet

strength cell sides. The 96% free area welded wire support grid shall be continuously bonded to the leaving air face of the media to properly support the radially tapered, pleated media in the air stream through the life span of the filter. The media itself shall be cemented to the inside perimeter of the cell sides to prevent bypass of unfiltered air. Filter efficiency shall average not less than 25 to 30% when tested in accordance with ASHRAE Test Standard 52-76. Initial clean resistance to air flow shall not exceed 0.30" w.g. at 500 fpm filter face velocity. The 24" x 24" size shall be certified to have a dust holding capacity of not less than 265 grams of ASHRAE Test Dust when operated at 500 fpm to a final resistance of 1.0" w.g.

E. Replaceable, Dry Type, Medium and/or High Efficiency (minimum MERV 13): Filters shall be 4" deep of the extended surface, supported pleat type. Each filter shall consist of high density, micro fine glass fiber media, media support grid, contour stabilizers, and enclosing galvanized steel frame. Media shall be laminated to a nonwoven synthetic backing to form a lofted surface for maximum dust holding capacity. The edges of the media shall be continuously bonded to the internal surfaces of the galvanized steel frame to prevent bypass of unfiltered air. Filter efficiency shall average not less than 80 to 85% when tested in accordance with ASHRAE Test Standard 52-76. Filters shall be 24" x 24" x 12" deep with an initial clean resistance not to exceed 0.35 inches w.g. at 500 fpm face velocity. The filters shall be certified to have a dust holding capacity of not less than 700 grams of ASHRAE Test Dust when operated at 500 fpm face velocity to a final resistance of 1" w.g.

F. Fabricate filter frames and supporting structures of 16 gauge galvanized steel or extruded aluminum T-section construction with necessary gasketing between frames and walls.

G. Standard Sizes: Provide for interchangeability of filter media of other manufacturers; for panel filters, size for required installation of filter media minimum 2 inch thick; for extended surface and high efficiency particulate filters, provide for upstream mounting.

H. Side Servicing Housing: Flanged for connection of ductwork, of reinforced 16 gauge galvanized steel; access doors with continuous gasketing and positive locking devices on both sides; extended aluminum tracks or channels for primary or secondary filters with positive sealing gaskets.

2.3 FILTER GAUGES

A. Each individual filter or filter bank handling 2,000 cfm or more shall be equipped with a diaphragm actuated dial and pointer type gauge with zero adjustment capability. The range of the scale shall be no greater than 1" W.G. above the filter manufacturer's recommended final resistance for the type of filter to which the gauge is being applied. Each gauge shall be provided with an adjustable signal flag, two static pressure tips with compression fittings, two (2) three-way vent valves with compression fittings, two lengths of aluminum tubing, and a mounting plate with screws.

B. Provide dry contact switch to indicate high-pressure limit (adjustable) for connection by others to Energy Management and Control System (ECMS).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air cleaning devices in accordance with manufacturer’s instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan system until filters temporary or permanent are in place. Replace temporary filter used during construction.

D. Install static pressure tips upstream and downstream of filers. Mount on outside of filter housing of filter plenum, in accessible position. Adjust and level.

E. Provide differential pressure sensor at filter bank of each air handling unit.

END OF SECTION 23 41 00

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Follow and comply with the SMSD MEP Electrical Standards.

C. Coordinate with Commissioning Requirements indicated in Section 019113. This Contractor is responsible to comply with all requirements for the above section.

1.2 SUMMARY

A. Section Includes:
1. Summary of Work.
2. Submittals, Analysis and Device Schedules.
3. Record Documents.
4. Operating and Maintenance Manuals.
5. General Electrical Product Requirements.
6. General Electrical Installation Requirements.
7. Electrical equipment coordination and installation.
8. Sleeves for raceways and cables.
9. Sleeve seals.
10. Grout.
11. Common electrical installation requirements.

B. Provide all work required for complete electrical and ancillary system as indicated on the drawings and in these specifications. This may include, but is not necessarily limited to; panelboards, transformers, cabinets, motor controllers, circuit breakers, fuses, disconnect switches, surge suppression, fire alarm system, Lighting Control System, interior and exterior lighting, parking lot lighting, lamps, relay panels, contactors, controls, wiring devices, wire and cable, grounding and bonding, lightning protection, equipment wiring system, conduit, raceways, boxes, supporting devices, identification, fire stopping, testing, excavating, concrete equipment bases, concrete duct encasements, conduit sleeves and supports, anchors, vibration and sound isolation, access panels, record drawings, installation permits, inspections by governing authorities, electrical work of certain temporary facilities and services, cutting-and-patching work, utility connection coordination, start-up of electrical systems and equipment, training of Owner's operating personnel, operating and maintenance manuals, final cleaning of electrical and similar work.

C. Except where otherwise indicated, electrical drawings prepared by Engineer (contract drawings) are diagrammatic in nature and may not show locations accurately for various components of electrical systems. It is the intention of the Construction Documents to establish the types and functions of the systems, but not to set forth each and every item essential to the functioning of any system. The Contractor shall make necessary changes or additions as may be reasonably inferred from the construction documents for a complete operating system as required and record these on the record documents at no cost to the Owner.

D. Contractor shall visit site prior to submitting his proposal and become familiar with the conditions under which the Work is to be performed, and correlate site observations with the requirements of the Contract Documents. Errors, inconsistencies or omissions discovered shall be reported to the Architect/Engineer at once.

E. All electrical products and installations shall comply with the latest additions of the following standards where applicable:
   1. ADA - AMERICANS WITH DISABILITIES ACT
   2. ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE
   3. ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS
   4. CBM - CERTIFIED BALLAST MANUFACTURERS
   5. ETL - ELECTRICAL TESTING LABORATORIES
   6. FM - FACTORY MUTUAL
   7. ICEA - INSULATED CABLE ENGINEERS ASSOCIATION
   8. IEEE - INSTITUTE OF ELECTRONICS AND ELECTRICAL ENGINEERS
   9. NEC - NATIONAL ELECTRICAL CODE
   10. NECA - NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION
   11. NEMA - NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
   12. NESC - NATIONAL ELECTRICAL SAFETY CODES
   13. NFPA - NATIONAL FIRE PROTECTION ASSOCIATION
   14. NETA - INTERNATIONAL ELECTRICAL TESTING ASSOCIATION
   15. OSHA - OCCUPATIONAL SAFETY AND HEALTH ASSOCIATION
   16. UBC - UNIFORM BUILDING CODE
   17. IBC – INTERNATIONAL BUILDING CODE
   18. ICC – INTERNATIONAL CODE COUNCIL
   19. IECC – INTERNATIONAL ENERGY CONSERVATION CODE
   20. ISO – INTERNATIONAL ORGANIZATION FOR STANDARDIZATIONUL
   21. UNDERWRITERS LABORATORIES, INC.
   22. TAS – TEXAS ACCESSIBILITY STANDARDS
   23. STATE ENERGY CONSERVATION CODE
   24. MUNICIPAL OR COUNTY CODES. In the event of conflicts between codes or standards, the more stringent requirements shall govern.

F. All work and materials shall be warranted as indicated in Division 1.

G. Contractor is responsible for filing and paying for all fees and obtaining necessary permits and certificates of inspection, and shall deliver all certificates of inspection to Owner, and include copies with maintenance manuals.

1.3 DEFINITIONS

A. NRTL: Nationally Recognized Testing Laboratory, including United Laboratories (UL) and Intertek (ETL).

1.4 SUBMITTALS

A. General Submittal Requirements:
   1. All submittals shall be in accordance with Division 1 requirements.
   1. Submit number of copies indicated in Division 1 or 6 copies, whichever is greater.
   2. Applicability: Wherever it is indicated that shop drawings, samples, manufacturer's brochure, certification, test, copy of standard operating instructions, manual, extra stock, or warranty is required, appropriate submittal is required regardless of whether it is specified as "submittal"; Engineer’s decision shall be final.
   3. Do not purchase equipment until submittals have been reviewed by Engineer with no exceptions taken.
   4. Signed Commitments: Do not proceed with transfer of electrical systems to Owner for operation until warranties, performance certifications, maintenance agreements and similar commitments to be signed by Contractor and other entities have been executed and transmitted to Engineer (for Owner's records).

5. Response to Submittals: Where standard product data have been submitted in fulfillment of project requirements, it is recognized that submitter has already determined that products fulfill specified requirements, and that submittals are for engineer's information only, but will be returned without action where observed to be non-complying with requirements. Where uniquely prepared information is submitted, it is recognized to represent preparer's interpretation or solution to specified requirements, subject to Engineer's concurrence and appropriate action as indicated in Division 1.
6. Submittals shall be signed by the General Contractor and Subcontractor responsible for this work.
7. The Engineer's review of submittals is solely for general conformance with the design concept. The Engineer's review does not relieve the Contractor from total responsibility for quantities, errors, omissions or compliance with the intent of the original contract documents. Review and approval by the Contractor is required before fabrication, shipment or installation.

B. Substitutions: Electrical submittals are not opportunities for gaining acceptance of substitutions. Any variance from the contract documents shall be identified in accordance with Division 1 requirements. Substitutions will be reviewed only for those reason identified in Division 1 and only if the procedures identified in Division 1 are followed. Any variances from the contract documents in the submittals which are not identified by the Contractor in accordance with the procedures of Division 1 and subsequently not identified by the Engineer's review shall be corrected by the Contractor at no cost to the Owner. Substitution request would only be considered if product is equal or better than what listed. No substitution will be allowed for fire alarm system and any electrical products and equipment.

C. Coordination Drawings: Prior to any submittals being reviewed, the Contractor shall provide the coordination drawings indicated in Division 1. In accordance with Division 1, the coordination drawings shall show 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. The coordination drawings shall be to a scale of 1/4" = 1'-0" or larger. Coordination drawings in the buildings shall include but not be limited to all Electrical rooms with size and location, major electrical equipment and accessories, switchgear and clearances, HVAC ductworks in rooms, plumbing, air grilles, light fixtures, communications equipment, access panels, transformers, switchboards, panelboards, control panels, fire alarm equipment, code clearances for equipment, manufacturers required maintenance clearance for equipment, concrete equipment pads, exterior wall penetrations, foundation penetrations, and fire rated wall penetrations.

D. Short Circuit Analysis: Prior to any electrical submittals being reviewed, the Contractor shall perform short-circuit analysis of the specified electrical power distribution system. This analysis shall include:
1. A calculation of the maximum RMS symmetrical three-phase short-circuit current available at each panel location in the electrical system. The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. The short circuit currents shall be calculated with the aid of a computer. The Contractor shall obtain necessary information from the utility to do this prior to furnishing equipment and coordinate with manufacturer to meet the greater of minimum required rating and rating indicated on Drawings.
1. Appropriate motor short-circuit contribution such that the calculated values will represent the highest short-circuit current to which the equipment will be subjected under fault conditions.
2. A tabular computer printout of equipment supplied by the electrical ratings of the electrical equipment supplied by the electrical manufacturer, the calculated short-circuits currents, X/R ratios, and notes regarding the adequacy or inadequacy of the equipment.

3. A computer printout of input circuit data including cable lengths, number of cables per phase, cable impedance values, insulation types, transformer impedances, X/R ratios and other circuit information as related to the short-circuit calculations.
4. A bus-to-bus computer printout listing the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current. This printout shall have an accompanying printout explaining how to interpret the short-circuit results.
5. A computer-generated system one-line diagram clearly identifying individual equipment buses, bus numbers used in short-circuit analysis, cable and bus connections between the equipment and calculated maximum short-circuit current at each bus location.
6. A discussion section evaluating the adequacy or inadequacy of the equipment, with recommendations as required for improvements to the system.
7. Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements.
8. Six (6) bound copies of the completed short-circuit analysis sealed by a Texas Licensed Professional Electrical Engineer shall be submitted for the Engineer to review.

E. Protective Device Time-Current Coordination Analysis: Prior to any electrical equipment submittals being reviewed, the Contractor shall perform a protective device time-current coordination analysis of the specified electrical power distribution system. This analysis shall include:
1. A determination of settings, ratings, or types for the over-current protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with:
   a. System protection shall be more important than service continuity. The time current condition analysis shall be performed with the aid of a computer.
2. Computer generated log-log plots containing the time current characteristics of over-current devices. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination. The log-log plots shall include transformer ANSI withstand point and inrush currents of transformers where appropriate. Series rated devices shall not be acceptable.
3. Computer printouts to accompany the log-log plots containing descriptions for each of the devices shown on the plot, setting of the adjustable devices, device numbers to simplify locations of the devices on the system one-line diagram and short circuits where shown.
4. A tabular computer printout of the suggested settings of the adjustable over-current protective devices, the equipment where the devices are located, the device number corresponding to the device on the system one-line diagram and the number of the time-current log-log graphs where they are illustrated.
5. A computer generated system one-line diagram clearly identifying individual equipment buses, the bus numbers, the device numbers and the maximum available short-circuit at each bus which shall include short-circuit current motor contributions.
6. A discussion section evaluating the degree of system protection and service continuity with over-current devices, with recommendations as required for increased protection or coordination.
7. Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements.
8. Six bound copies of the completed protective device time-current coordination analysis for the engineer.

F. Over-current Device Schedule: Prior to any electrical submittals being reviewed, Contractor shall provide a schedule for each piece of equipment required by Divisions 11, 14, 21, 22, 23, 25, 27, and 28 in coordination with subcontractors providing equipment under these sections. Submittals shall reflect required coordination by having related Contractor's signatures on the submittals. This means that electrical requirement for chiller as an example, shall be coordinated by BOTH Electrical and Mechanical subcontractors, and Over-Current Device Schedule submitted shall be signed by both Contractors. For each piece of equipment actually

supplied, the schedule shall indicate the full load amps (FLA), the minimum circuit amps (MCA), and the maximum over-current protection device (MOCPD). The schedule shall also indicate if the equipment is required to be protected by fuses only, thermal magnetic breaker only, HACR breakers only or any combination thereof. It shall also indicate if the equipment requires single point or multiple point of connections and hoe the Contractor is proposing to meet the requirements if different than construction documents. It shall explicitly indicate the required number of conductors, disconnect switch sizes and numbers (if required), and acceptable conduit sizes and number. These modifications shall be reflected in the electrical equipment submittal. Required changes shall be made at no cost to the Owner.

G. After the coordination drawings, short circuit analysis coordination analysis and over-current device schedule are submitted, the products in Division 26 shall be submitted in the groups identified below. By submitting shop drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other trades. Submittals for each group will be returned without review unless all sections are included. Sections will not be reviewed separately. At the Engineer's discretion, when a re-submittal is required for one section, any other sections within each group may require re-submittal. Contractor shall expedite submittals and re-submittals as required to allow for the Engineer's review time specified in Division 1. The groups of equipment shall be divided as follows:

1. Raceways, Conductors and Miscellaneous Equipment
    a. Fire stopping
    b. Conduit
    c. Raceways, Multi-outlet Assemblies, Wireways and Auxiliary Gutters
    d. Wires and Cables
    e. Outlet Boxes
    f. Wiring Devices
    g. Cabinets and Enclosures
    h. Grounding and Bonding
    i. Supporting Devices
    j. Electrical Identification
    k. Lightning Protection Systems
2. Distribution Equipment
    a. Distribution Switchboards
    b. Enclosed Switches
    c. Dry Type Transformers
    d. Distribution Panelboards
    e. Branch Circuit Panelboards
    f. Enclosed Motor Controllers
    g. Motor Control Center
    h. Variable Speed Drives
3. Electrical Controls
4. Emergency Backup System
    a. Enclosed Automatic Transfer Switches
    b. Natural Gas Generator Sets
5. Lighting Fixtures
    a. Interior and Building Lighting Fixtures
6. Specialty Systems
    a. Transient Voltage Surge Suppression
    b. Fire Alarm System
    c. Intercom System
    d. Cable TV System
    e. Local sound reinforcement System
7. Testing

a. Field Electrical Testing

H. Shop Drawings: Prepare electrical shop drawings to accurate scale except where diagrammatic representations are specifically indicated. Show clearance dimensions of critical locations, and show dimensions of spaces required for operation and maintenance of equipment. Show conduit layouts and wire/cable connections and other electrical service connections and show interfaces with other work, including structural support. Indicate by note, portions of electrical work shown on shop drawings which deviates from indication of work in contract documents, and explain reasons for deviations. Show how such deviations coordinate with interfacing deviations on shop drawings for other portions of work, currently or previously submitted. Show wiring diagrams, erection, setting, weights, capacities, speeds, outputs, consumption, efficiencies, voltages, amperages, hertz, phases, noise levels, etc.

I. Samples: Engineer's review of required sample submittals will be limited to observation of general type, pattern, and finish; and will not include testing and inspection of submitted samples, except for those specifically indicated for that purpose in the contract documents. Compliance with specified requirements remains the exclusive responsibility of the Contractor.

J. Manufacturer's Data: Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which variations are to be provided. Delete or mark-out all portions or pre-printed data which are not applicable. Where operating ranges are shown, mark data to show portions of range required for project application. Expansion or elaboration of standard data to describe non-standard product must be processed as shop drawing data to describe non-standard product. For each product include manufacturer's production specifications, installation or fabrication instructions, nearest source of supply (including telephone number), sizes, weights, speeds, operating characteristics, ratings, conduit and wire/cable connection sizes and locations, statements of compliance with required standard and governing regulations (include manufacturer's signed statements if not covered in printed data), performance data (where applicable) and similar information needed to confirm compliance with requirements.

K. Manufacturer's Certification: Each manufacturer is required to review the system design as related to the proper operation of his equipment, including electrical requirements, automatic controls, mechanical systems and equipment locations and related items. With shop drawings submit a letter from the manufacturer stating that his equipment will operate satisfactorily under the design conditions. The manufacturer's representative shall review the final installation at the site and submit a second letter stating that the equipment operates satisfactorily as installed. Furnish certification for the systems listed in each section of Division 26.

1. Test Reports: The Contractor for various sub-systems shall submit proposed testing procedure for their system, subject to review and approval and owner acceptance. The contract will not be declared to be substantially complete until the functional operation of the subsystems have been demonstrated and verified and reports have been provided, reviewed and accepted. The project will not be declared substantially complete until the following has taken place:
2. The “As-Built” drawings have been submitted, reviewed, and accepted by SMSD CM-PA/Bond Office.
3. The various systems have been commissioned and accepted. This will include the following systems:
   a. Building Fire Alarm System
   b. Clock System
   c. Television Distribution System
   d. Building Computer Network
   e. Surveillance and Security System
   f. Intercom/Telephone

L. Submit test report signed and dated by firms performing test, and prepare in manner specified in standard or regulation governing test procedure as indicated. Provide notarized executions on test reports.

M. Warranties: Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. A minimum of one-year warranty period is required for all materials and equipment. Warranty period starts upon first beneficial use or acceptance by SMSD whichever comes first.
   1. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; names, addresses and telephone numbers and procedures for filing a claim and obtaining warranty services.
   2. Where pre-printed and published warranty includes substantial deviation from required warranty (as judged by Engineer), product is automatically disqualified from use on project, except where manufacturer prepares and issues specific project, warranty on product, stating that it is in lieu of published warranty, and is executed by authorized officer, and complies with requirements.

N. Load Current and Overload Relay Heater List: Compiled by Contractor after motors have been installed. Arrange to demonstrate selection of heaters to suit actual motor nameplate full load currents.

1.5 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, indicate installed conditions for:
   1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; access panels; and fuse and circuit breaker size and arrangements.
   1. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   2. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
   3. Underground cabling and conduits both interior and exterior, drawn to scale and fully dimensioned.
   4. Work concealed behind or within other work, in a non-accessible arrangement.
   5. Mains and branches of wiring/cabling systems, with switchboards, panelboards, and control equipment and devices located and numbered with terminals and connections located, and with equipment requiring maintenance located.
   6. Grounding systems including primary, secondary and special.

B. Execution: Each installer or other entity responsible for recording installed work shall record firm name, signature and date on each drawing so marked.

C. Prior to transmittal of corrected drawings, obtain three (3) sets of blue-line prints of each drawing in each set, regardless of whether corrections were necessary, and include in transmittal (two (2) sets are for Owner's use, and one (1) is for Engineer's records).

1.6 OPERATING AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1. In addition to the requirements specified in Division 1, provide the following.

B. Submit sets prior to final inspection, in electronic PDF format.

C. Contents:
   1. Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractor, and major equipment suppliers.
   1. Operation and maintenance instructions, arranged by system.
   2. Project documents and certificates.
   3. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   4. Manufacturer's original printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions. (Copies are not acceptable).
   5. Maintenance procedures for routine preventative maintenance and troubleshoot; disassembly, repair, and re-assembly; aligning and adjusting instructions.
   6. Servicing instructions and lubrication charts and schedules.
   7. Warranty information including any corrections made during submittals.
   8. Replacement parts list.
   9. List of tools and accessories needed for maintenance.

1.7 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   1. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   2. To allow right of way for piping and conduit installed at required slope.
   3. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 GENERAL MANUFACTURER QUALIFICATION

A. Production Experience: For all electrical equipment, manufacturer shall be firm with not less than five (5) years successful production experience. Experience means production of units similar to those required, as judged by Engineer. Comply with longer-period experience requirements specified in other Division 26 sections of these Specifications. Product shall be new and design for quiet, vibration free operation.

2.2 GENREAL ELECTRICAL PRODUCT REQUIREMENTS

A. Standard Products: Provide not less (quality) than manufacturer's standard products as specified by published product data. Do not assume that available off-the-shelf condition of product complies with requirements; as example, specific finish or color may be required.

B. Unencumbered Purchases: Avoid purchases and use of products which are encumbered with questionable title transfers, patent rights, trade union restrictions, code compliance, non-listings as "approved products" for compliance with governing regulations, duties due, embargoes and similar possible encumbrances, claims or seller's interest.
   1. Purchasing: Do not purchase specific electrical materials and equipment for project until completion of submittals.

C. Condition of Products: Except as otherwise indicated, provide new electrical products, free of defects and harmful deterioration at time of installation. Do not use units, which have been subjected to destructive testing, or other high-limits testing except where pre-tested products are specified. Comply with Division 1 requirements for exposure or visual display limitations against trademarks and manufacturer's names. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of products, or required by governing regulations.

D. Assembly and Testing: To greatest extent possible and unless otherwise indicated, complete fabrication, assembly, finishing and testing of products prior to delivery to project. Notify Engineer not less than one week in advance of pre-installation testing to be performed in response to project requirements. Engineer reserves right to be present at tests of electrical products; however, neither their absence nor presence relieves the Contractor of responsibility for compliance with requirements.

E. Uniformity: Where multiple units of generic product are required for single major system of electrical work, e.g., cable trays, lighting systems, provide identical products by same manufacturer, without variations.
   1. Limitations: Product/manufacturer uniformity does not apply to conduit and fittings, 600V electrical wire, sheet metal, steel bar stock, welding rods, solder, factory applied paint between different systems, fasteners, motors for unalike equipment units, and similar items used in work, and except as otherwise indicated.

F. Product Compatibility, Options: Where more than one product selection is specified, selections are Purchaser's or Installer's options, except do not provide products which are not compatible with previously purchased or installed products which must interface with selections. Provide electrical adaptations as needed for interfacing of selected products in work.

G. Quality Assurance: Provide products listed by and installed in accordance with all references in each section under quality assurance any other applicable requirements.

H. Elevation Requirements: Electrical equipment provided shall perform at mean elevation of 1000 feet above sea level.

I. Listing: Provide products that are listed by a NRTL.

2.3 SLEEVES FOR RACEWAYS AND CABLES

A. Retain one of first two paragraphs below for penetrations through exterior walls above and below grade.

B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

C. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.

D. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.4 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

2.5 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 GENERAL ELECTRICAL INSTALLATIONS

A. The Contractor shall provide all necessary items for a complete operating system.

B. Provide all electrical systems required by and in accordance with Division 26.

C. Perform work for other divisions as required for electrical installations or coordinate such work with other trades which includes but is not necessarily limited to:
   1. Division 1: Cutting and Patching, Temporary Controls, Submittals, Facility Start-up, Contract Close Out, Record Documents, etc.
   2. Division 2: Trenching, Backfilling, Compaction, Demolition, etc.
   3. Division 3: Concrete Formwork.
   4. Division 5: Metal Fabrications.
   5. Division 6: Rough Carpentry.
   6. Division 7: Joint Sealers and Fire Stopping
   7. Division 8: Electric Door Hardware and Access Doors
      a. Deviation: Contractor is encouraged to coordinate and combine electrical access with mechanical access, and has the option to not add electrical access panels if acceptable coordination can be achieved.
   8. Division 9 - Painting: In addition to Division 9, paint electrical equipment factory applied paint surfaces damaged during installation with paint purchased from equipment manufacturer to match each damaged surface.
   9. Divisions 11 and 13: Laboratory Furniture, Electronic Systems, Intercoms, etc.
   10. Division 15 for motors, controls, accessories, and connections.

D. Verify all dimensions by field measurements.

E. Arrange for chases, sleeve, slots, and openings in other building components during progress of construction, to allow for electrical installations.

F. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

G. Where mounting heights or locations are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom and working clearances possible, but not less than required by Code.

H. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings and manufacturer's instructions, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

I. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

J. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

K. Install J-boxes for all other equipment requiring access or maintenance, which are concealed behind surfaces so that these devices can be serviced from the access panels. Where practical, group J-boxes and equipment so that they can be accessed from the same panel or door. If additional panels are needed, panels must be submitted for approval.

L. Cut, remove and legally dispose of selected electrical equipment, components, and materials, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new work.

M. The A/E reserves the right to make relocations up to 6 feet of outlets, boxes, cabinets, lighting, etc. before finished rough-in at no cost to the Owner.

N. Contractor shall notify design prime consultant and associated owner representative when he requests an inspection by the City Inspector.

3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: 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".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe 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.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use 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.

3.5 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protection and Identification: Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identification; adequately packaged or protected to prevent deterioration during shipment,

storage and handling. Store in dry, well ventilated, indoor space, except where prepared and protected by manufacturer specifically for exterior storage.

3.7 DAMAGED EQUIPMENT

A. The following will be rejected (even after final installation) and must be replaced with same as original at no cost to Owner:
   1. Dented, deformed, stepped-on, or otherwise physically damaged enclosures.
   2. Stripped cover plate screws and the holes they screw into.
   3. Door hinges that do not operate smoothly.

B. The following will require field repair to original condition:
   1. Minor scratches to equipment enclosure finishes.

3.8 TEMPORARY WIRING

A. The electrical Contractor shall arrange for and provide all necessary equipment, outlets, temporary lights, metering and communications as required during the construction period for temporary electrical service to the project.

B. It shall be the responsibility of the electrical Contractor to consult with all other trades on the project in order to determine the voltage of temporary electrical service required to operate the construction equipment to be employed and to provide such services to the project.

C. It shall be the responsibility of the electrical Contractor to make all arrangements for, and to furnish and install, any and all temporary wiring, switches, and structures which may be required to maintain service continuity during the entire construction period. Temporary power and lights shall be UL listed and shall include a ground wire, a guard and a proper means of support.

D. All temporary installations shall be performed in accordance with the current edition of the National Electrical Code. All machinery and equipment powered by electricity shall have effective electrical equipment grounding provided with all electrical circuits.

3.9 UTILITIES

A. This Contractor shall examine the site and shall verify, to his own satisfaction, the location and elevation of all utilities, and shall adequately inform himself as to their relation to the work before entering into a contract.

B. Existing utility lines shown within the scope of this project to be abandoned or removed shall be performed as directed by the Owner, and/or utility companies.

C. Existing utility lines not shown on the drawings but encountered during construction shall be protected, relocated or capped as directed by the Owner, and/or utility companies. All precautions shall be exercised to prevent damage to existing lines not shown, but should work become necessary, it must be authorized prior to execution except in an emergency situation.

D. Before beginning excavations of any nature whatsoever, the Contractor shall make an attempt to locate all underground utilities of every nature occurring within the bounds of the area to be excavated. The Contractor shall then proceed with caution in his excavation work so that no utility shall be damaged with a resultant loss of service.

E. Should any damage result to any utility through the Contractor's negligence or failure to comply with the above directive, he will be liable for such damage and for all expense incurred in the expeditious repair or replacement of such damaged utilities.

F. Repair of damaged utilities shall be to a condition equal to or better than the adjacent undamaged portion of such utility and to the complete satisfaction of the Owner and/or utility companies.

3.10 EXCAVATION

A. The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated and/or required for the installation of all portions of the utilities systems. All excavated materials not required for fill or backfill shall be removed. All excavation shall be made by open cut. The banks of trenches shall be kept as nearly vertical as practicable and where required shall be properly shored and braced. Trenches shall be at least 12" wider and not more than 16" wider than the outside diameter of the conduit, and shall be excavated true to line so that a clear space greater than 6" and less than 8" in width is provided on each side of the conduit or duct bank.

B. Except at locations where the excavation of rock from bottom of trenches is required, care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum over-depth of 4" below the trench depths indicated on the drawings or as specified. The over-depth rock excavation shall be back-filled with loose, moist earth and thoroughly tamped.

C. Whenever wet or otherwise unstable soil that is incapable of supporting the conduit duct bank, pole base or pad is encountered in the trench bottom, such soil shall be removed to a depth required. The trench bottom shall be filled with course sand, fine gravel, or other suitable material.

D. Backfill with earth under pole bases, pads or other buried structures will not be permitted, and any unauthorized excess excavation below the levels indicated for foundation of such structures shall be filled with sand, gravel or concrete at the expense of the Contractor.

E. All grading in the vicinity of excavations shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or by other approved method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from the edges of trenches to avoid overloading and to prevent slides or cave-ins.

3.11 BACK-FILLING

A. Trenches shall not be back filled until all required tests are performed and until the utilities systems as installed conform to the requirements specified.

B. Trenches shall be carefully back filled with the excavated materials approved for back filling. This material shall consist of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials, free from large clods of earth or stones, deposited in thoroughly and carefully tamped 6" layers, until the conduit has a cover as specified. Broken rock, broken concrete or pavement, and large boulders shall not be used as backfill material.

C. Settling the backfill with water will be permissible and will be a requirement when so directed.

D. Any trenches across roadways or other areas to be paved shall be back filled with flowable fill (CLSM) or approved equal (ashes combined with concrete) in such manner as to permit the rolling and compaction of the filled trench. Together with the adjoining earth, shall provide required bearing value so that paving of the area can proceed immediately after the backfilling is completed.

3.12 CLOSEOUT PROCEDURES

A. General Coordination: Refer to Division 01 sections and individual Specification sections for coordination of electrical closeout work with variable loads on electrical system. Coordinate taking of final photographs (if any) with electrical closeout, so that maximum detail of work as finally accepted is shown. Sequence closeout procedures properly, so that work will not be endangered or damaged, and so that every required performance with be fully tested and demonstrated.

B. System Performance Test Runs: Coordinate test runs of electrical systems with test runs of equipment served thereby (heating, air conditioning, plumbing, etc.). Check each item in each system to determine that it is set for proper operation. With Owner's Representative and Engineer present, operate each system in test run of appropriate duration to demonstrate compliance with performance requirements. During or following test runs, make final corrections or adjustments of systems to refine and improve performances where possible, including noise and vibration reductions, elimination of hazards, better response of controls, signals and alarms, and similar system performance improvements. Provide testing or inspection devices as may be reasonably requested for Engineer's observation of actual system performances. Demonstrate that controls and items requiring service or maintenance are accessible.

C. Cleaning and Lubrication: After final performance test run of each electrical system, clean system both externally and internally. Comply with manufacturer's instructions for lubrication of both power and hand-operated equipment, and remove excess lubrication. Touch-up minor damage to factory-painted finishes and other painting specified as electrical work; refinish work where damage is extensive.

D. General Operating Instructions: In addition to specific training of Owner's operating personnel specified in individual Division 26 work sections, and in addition to preparation of written operating instructions and compiled maintenance manuals specified in Division-26 Sections and elsewhere in these specifications, provide general operating instructions for each operational system and equipment item of electrical work. Coordinate instructions with instructions for mechanical work, elevators and other equipment where associated with electrical systems or equipment.
   1. Describe each basic electrical system and functioning of its control system.
   2. Explain identification system, mimic diagrams, signals, actuators, sensors, alarms, telecommunication systems, and similar audio/visual provisions.
   3. Describe interfaces with mechanical equipment, including interlocks, sequencing, start-up, shut down, emergency, safety, system failure, security and similar provisions.
   4. Outline basic maintenance procedures and major equipment turnaround requirements, including adjustments to optimize output and efficiency of electrical system.
   5. Display and conduct "thumb-through" explanation of maintenance manuals, record drawings, spare part inventory, storage of extra materials, meter readings and similar service items.

E. Construction Equipment: After completion of performance testing and Owner's operating instructions and demonstrations, remove installer's tools, test facilities, construction equipment and similar devices and materials used in execution of work but not incorporated in work.

F. Security and Protection: During electrical work closeout phase, meet with Owner's operating representative frequently (daily where necessary) and agree upon status of operational responsibility for electrical systems (including securing provisions to prevent unauthorized operations, and including protective measures to ensure that systems are not neglected or misused.

PART 4 - CONTINUED SYSTEM OPERATIONS

A. Acceptance and Continued Services: Coordinate Owner's take-over of electrical systems with take-over of mechanical systems, including the provision of skilled electrical operating and maintenance personnel until time Owner's personnel take over operation of entire mechanical and electrical plant. Contractor shall continue consultation and services (beyond take-over date) for electrical systems, matching required continued services on associated mechanical systems and equipment.

END OF SECTION 26 05 00

SECTION 26 05 19 – 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. This Section includes the following:
   1. Building wires and cables rated 600V and less.
   2. Connectors, splices, and terminations rated 600V and less.
   3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:

C. List below only products and equipment that the reader might expect to find in this Section but are specified elsewhere.
   1. Division 27.

1.3 DEFINITIONS

A. Retain abbreviations that remain after this Section has been edited.

B. EPDM: Ethylene-propylene-dieneterpolymer rubber.

C. NBR: Acrylonitrile-butadiene rubber.

D. MCM: Thousand circular-mils.

1.4 SUBMITTALS

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

B. Coordinate paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

C. Qualification Data: For testing agency.

D. Retain paragraph below if Contractor is responsible for field quality-control testing.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Retain first paragraph and subparagraph below if Contractor is required to provide services of an independent testing agency in Part 3 "Field Quality Control" Article. Qualification requirements supplement those specified in Division 01 Section "Quality Requirements", which also includes the definition for NRTL.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing

Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. UL Compliance: Provide components which are listed and labeled by UL under the following standards.
1. UL Std. 83 - Thermoplastic-Insulated Wires and Cables.
2. UL Std. 4 - Armored Cable
3. UL Std. 1569 - Metal-Clad Cables
4. UL Std. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
5. UL 13 - Power limited circuit cables.
6. UL 1666 - Test for flame propagation height of electrical and optical-fiber cables installed vertically in shafts.
7. UL 910 - Test for flame propagation and smoke density values for and optical fiber cables used in spaces environmental air.
8. UL 1685 - Vertical tray fire propagation and smoke release test for and optical fiber cables.

F. NEMA WC-5: Thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.

G. Federal Specifications
1. J-C-30B (1) cable and wire, electrical (power, fixed installation).

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers, 600 Volt or Less Wire and Cable: Subject to compliance with requirements, provide products by one of the following:
1. Encore Wire
2. General Wire.
3. South wire.

B. Manufacturers, Low Voltage Wire (300V and under): Subject to compliance with requirements, provide products by one of the following
1. Alpha.
2. Belden.
3. West Penn.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, XHHW, UF, USE and SO. All conductors are to be Copper wire or cable insulated for 600 V, color coded for the entire length. Use of electrical tape for marking is strictly prohibited.
   1. Conductors shall be provided with insulation types indicated explicitly on drawings, and substitution is NOT acceptable without Engineer's approval.
   2. Wiring BX and MC will not be acceptable for use on this project. MC may be used for light fixture whips only.
   3. Where insulation type is not explicitly identified on drawings, branch circuit and feeder circuit conductors shall have THHN-THWN dual-rated insulation.

E. Multi-conductor Cable: Comply with NEMA WC 70 for armed cable, Type AC, metal clad cable, Type MC, mineral-insulated, sheathed cable, Type MI with ground wire.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Hubbell Power Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

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 a comparable product by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Copper:
1. Solid for #10 AWG and smaller;
2. Stranded for #8 AWG and larger.

B. Aluminum:
1. Use only for distribution or service feeders where explicitly indicated on Drawings.
2. Use AA-8030 alloy only.
3. Stranded only
4. Minimum size: 250 MCM.
5. Provide compression lugs.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2 single conductors in raceway, unless specifically noted otherwise on Drawings.

B. Feeders to Switch Boards, Distribution-Class Panels, and Motor Control Centers located in central plant or main electrical room: Type XHHW-2 single conductors in raceway, unless specifically noted otherwise on Drawings.

C. Feeders to Distribution-Class Panels, Lighting-Class Panels, and distribution equipment located in any other area: Type THHN/THWN-2 dual-rated insulation conductors in raceway, unless specifically noted otherwise on Drawings.

D. Feeders to Emergency Equipment: Type RHW-2, unless specifically noted otherwise on Drawings.

E. Branch Circuits: Type THHN/THWN-2 dual-rated insulation conductors in raceway, unless specifically noted otherwise on Drawings.
1. Lighting Fixture Tails: A maximum of 6'-0" length of multi-conductor cable may be used for lighting fixture connection from above-ceiling junction boxes with Code-required support and minimum of one support point between junction box and fixture.
2. Wiring Devices: Multi-conductor cable is not acceptable for use in connection of wiring devices and associated boxes.
3. Equipment: Multi-conductor cable is not acceptable for use in connection of equipment by any Division.

F. Control Circuits: Type THHN/THWN-2 in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway. Do not re-pull wires/conductors that been used. Do not use rope hitches for pulling attachment to wire or cable.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. All wire shall be installed in conduit or raceways.

H. All circuits shall have a hot, neutral and green ground wire unless otherwise indicated.

I. Provide #12 conductors and #12 grounds minimum to all 20 amp devices unless otherwise indicated.

J. Provide #10 conductors and #10 grounds minimum to all 30 amp devices unless otherwise indicated.

K. Provide #10 minimum conductors for 20 amp circuits ≤ 150 VAC line-to-neutral for which the distance from the panelboard to the first device is greater than 100 feet.

L. Provide #10 minimum conductors for 20 amp circuits > 150 VAC line-to-neutral for which the distance from the panelboard to the first device is greater than 200 feet.

M. Do not install wires in conduit until entire system of conduit and outlet boxes is permanently in place.

N. Exercise care when installing wire in conduit so as to prevent injury to the conductor insulation. Mechanical means of pulling shall not be used unless approved. Conductors shall be pulled using UL non-flammable listed lubricant when necessary. Do not re-pull wires/conductors that been used.

O. Whenever wiring leaves the conduit and terminates at a terminal board, the wiring shall be formed and laced with plastic wire ties. Conductors are to be installed neat, order and workmanlike manner and also comply per NEC 70; Article 312.

P. In the event circuits feed through outlet boxes, provide splice and pigtail for device connection, with sufficient slack to pull splice out of box at least 6 inches (for inspection). Terminate the conductors around the terminal screws not at the back of the receptacle.

Q. Coordinate cable installation with other Work.

R. Pull conductors simultaneously where more than one is being installed in same raceway.

S. Splices:
   1. Branch Circuits: Keep conductor splices to a minimum.
   2. Motor Branch Circuits: Splices are not allowed in motor branch circuit feeders.
   3. Relocation of Existing Lighting-Class Panels: Provide splices to existing branch circuits that are active and will remain in above-ceiling junction boxes sized appropriately for the quantity of conductors. Verify existing branch circuit feeder condition and ampacity and provide new feeders where existing violations exist. Match and extend branch circuit

feeders from splice to new panel location and provide new branch circuit breaker as indicated in Panel Schedules to re-feed existing load.

4. Service Entrance Feeders: Splices are not allowed in any service entrance feeder(s). All conductors must be single length.
5. Distribution Feeders: Splices are not allowed in any distribution feeder(s) including, but not limited to feeders between switch boards, distribution-class panels, lighting-class panels, motor control centers, transformers, safety switches, and motor controllers and drives.
6. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced.
7. Use splice and tap connectors which are compatible with conductor material.

T. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than no.10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

U. Home Runs: except where specifically indicated, provide lighting branch circuit home runs with not more than three different line conductors and a common neutral in a single raceway for 4-wire, 3-phase systems.

V. Conductors may be run inn parallel in sizes 1/0 through 750 MCM where indicated and provided that all conductors of each phase are the same length and so arranged and terminated as to ensure equal division of the current between all paralleled phase conductors.

W. Feeders shall be installed in continuous pieces without splice.

X. Install a separate neutral for each circuit which serves GFCI or isolated ground receptacles.

Y. Each circuit originating from a GFCI type circuit breaker shall also have a separate neutral.

Z. Where specifically indicated, for receptacle branch circuits, provide a separate neutral conductor for each line conductor.

AA. Each circuit serving receptacles where data terminals are used shall have separate neutral.

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 and UL 486B. Provide Documentation and records all torque terminations.

B. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack per Section 300.14.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
   2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

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 Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   3. Perform insulation resistance test for all branch and main circuit conductor. Perform test on each conductor with respect to ground and adjacent conductor. Applied potential shall be 1000 volts DC for one minute. Test values shall be evaluated and conductors with values less than 50 megohms shall be investigated. Replace any cable reading less than 1 megohm.
   4. Provide torque test for all conductor terminations in transformers, switchboards; disconnect switches, panelboards, etc in accordance with NETA standards. Record test result in accordance with item D below.
   5. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each termination of cables and conductors No. 3 AWG and larger. Remove box and equipment covers so terminations are accessible to portable scanner.
      a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      b. Record of Infrared Scanning: Prepare a certified report that identifies terminations checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

E. Cleaning:
   1. Clean the area around and on top of the equipment.

END OF SECTION 26 05 19

SECTION 26 05 26 - 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, plus the following special applications:
   1. Underground distribution grounding.
   2. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

B. Product Data: For each type of product indicated.

A. Product Samples: Only for Ground Rods, provide one to Engineer for approval to be turned over to Owner as attic stock after substantial completion.

B. Retain paragraph and subparagraphs below to require that Contractor provide drawings to locate significant grounding features. Division 01 Sections "Project Record Documents" and "Operation and Maintenance Data" require submittals to be included in those documents for use by maintenance forces throughout the life of the Project.

C. 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. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.
   5. Grounding for sensitive electronic equipment.

D. Qualification Data: For testing agency and testing agency's field supervisor.

E. Field quality-control test reports.

F. 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 ground rings grounding connections for separately derived systems based on NFPA 70B.
      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.
      c. Records documentation is required for all testing.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience, certified 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 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

A. Acceptable Manufacturers: Erico, Copper weld, Cad weld, Bundy

2.2 CONDUCTORS

A. Insulated Conductors: All conductors are to be Copper wire or cable insulated for 600 V,color coded for the entire length. Use of electrical tape for marking is strictly prohibited.

B. Bare Copper Conductors: Only where specifically indicated on Drawings.
1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch 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 2 inches in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING ELECTRODES

D. Ground Rods: Copper-bonded steel; 3/4 inch diameter by 10 feet length; minimum 13 mil plating thickness.

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 below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches 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, minimum, from wall 6 inches 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.
   3. Install grounding conductor from main service to the grounding bus. The minimum conductor used per Article 250.

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.
   4. Connections to Structural Steel: Welded 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 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 above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded,

hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

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.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

B. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in

raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. 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 below finished floor or final grade, unless otherwise indicated.
1. Use same-manufacturer, matched driving tool to drive ground rods without deformation. “Mushroomed” or otherwise deformed rods will be field-rejected.
2. Replace grounding rods that are deformed at no cost to Owner.
3. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated.
4. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
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 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 apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building.
1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building foundation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. 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. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal 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.
3. 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.

C. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 1 Ω.
2. Power Distribution Units or Panelboards Serving Electronic Equipment: 0.5 Ω.
3. Substations and Pad-Mounted Equipment: 0.5 Ω.
4. Manhole Grounds: 5 Ω.

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 - 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. Follow and comply with SMSD MEP Electrical Standards.

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. Retain abbreviations that remain after this Section has been edited.

B. EMT: Electrical metallic tubing.

C. IMC: Intermediate metal conduit.

D. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. 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 SUBMITTALS

A. Product Data: For the following:
1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
3. Trapeze hangers. Include Product Data for components.
4. Steel slotted channel systems. Include Product Data for components.

5. Nonmetallic slotted channel systems. Include Product Data for components.
6. Equipment supports.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 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. Retain this Article to specify default product requirements for basic supporting devices. Items to be supported include raceways, cables, wireways, cable trays, busways, boxes, cabinets, equipment, and other electrical products. Where support materials or workmanship is unique to a particular product, specify unique features that are the exception to these default requirements in the Section that specifies the product. Coordinate specifications for supporting devices with structural engineer and with Drawings.

B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. Thomas & Betts Corporation.
      e. Unistrut; Tyco International, Ltd.
   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.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
   6. 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:

7. 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. Fabco Plastics Wholesale Limited.
8. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
9. Fitting and Accessory Materials: Same as channels and angles except metal items may be stainless steel.
10. Rated Strength: Selected to suit applicable load criteria.

D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

E. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

F. 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.

G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   11. 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. 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) 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.
   12. Mechanical-Expansion Anchors: Insert-wedge-type, steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. 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.
   13. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   14. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

15. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
16. Toggle Bolts: All-steel springhead type.
17. Hanger Rods: Threaded steel.

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

C. 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.

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

G. All conduits shall be installed in uniformity, neat and equal space.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.
5. 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

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 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, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

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.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.
9. Identification of Boxes, Junction Boxes and Pull Boxes
10. Identification of Switchboards, Motor Control Center, Panelboard, transformers, disconnecting means, Timer and etc.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions riveted to the metal surface, and graphic features of identification products.

A. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

A. Comply with NFPA 70.

B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

C. Comply with ANSI Z535.4 for safety signs and labels.

B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 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. Colors for Raceways Carrying Circuits at More Than 600 V:
   1. Black letters on an orange field.
   2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high letters on 20-inch centers.

D. 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.

E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch-wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

I. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED AND METAL-CLAD 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.

A. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Colors for Raceways Carrying Circuits at More Than 600 V:
3. Black letters on an orange field.
4. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high letters on 20-inch centers.

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.

C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 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.

A. 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.

B. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

C. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

A. 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.

B. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

C. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

E. All conductors shall have the color of insulation for the entire length. Do not use electrical tape to identify the colors. This applies in all sizes.

2.5 FLOOR MARKING TAPE

A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 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.

A. Color and Printing:
   4. Comply with ANSI Z535.1 through ANSI Z535.5.
   5. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
   6. Inscriptions for Orange-Colored Tapes: TELEPHONE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

A. 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.

B. Baked-Enamel Warning Signs:
   1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal size, 7 by 10 inches.

C. Warning label and sign shall include, but are not limited to, the following legends:

D. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. No adhesive is strictly prohibited.

B. 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. Overlay shall provide a weatherproof and UV-resistant seal for label. No adhesive is strictly prohibited.

C. Punch or drilled riveted Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch. No adhesive is strictly prohibited.

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch. No adhesive is strictly prohibited.

A. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

E. Only use drilled/punched riveted label on equipment.

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.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black except where used for color-coding.

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.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one-piece, self-locking.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 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 maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. 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.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Identification of Electrical Systems
   1. Identify all equipment and circuit breakers.
   2. Identify all J-box covers with circuit numbers.
   3. On all device wall plates, on inside of plate, indicate panel and circuit number feeding the device.
   4. All electrical panels shall have type written panel schedule with room descriptions using actual room signage numbers.
   5. Electrical systems shall be identified by painted junction boxes and covers with the following scheme:
      a. Lighting system: Yellow
      b. Emergency Power: Red
      c. 120V Power: Blue

d. HVAC system power: Green

6. Electrical panel identification shall include the following:
   a. Panel Name
   b. Voltage
   c. Amperage
   d. General description such as: Lighting Area A or Power Area C. Refer to Drawings.
   e. Appropriately colored for emergency.
   f. Feeder panel designation must be clearly identified.

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 maximum intervals.

C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   1. Emergency Power.
   2. Power.

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and hand-holes, 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. New Conductors: Insulation shall be fully and continuously colored. Phase taping is not acceptable.
      b. Colors for 208/120-V Circuits:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral: White
         5) Ground: Green
      c. Colors for 480/277-V Circuits:
         1) Phase A: Brown.
         2) Phase B: Purple
         3) Phase C: Yellow.
         4) Neutral: Gray/White
         5) Ground: Green

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 marker tape to conductors and list source.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

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. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
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. Power transfer switches.
   b. Controls with external control power connections.

K. 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.

L. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

M. 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: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   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: Use punched, drilled riveted label or identifications
   a. Panelboards: Typewritten hard thick card stock paper directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be laminated acrylic or melamine label.
   b. Enclosures and electrical cabinets.
   c. Access doors and panels for concealed electrical items.
   d. Switchboards.
   e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
   f. Substations.
   g. Emergency system boxes and enclosures.
   h. Motor-control centers.

i. Enclosed switches.
j. Enclosed circuit breakers.
k. Enclosed controllers.
l. Variable-speed controllers.
m. Push-button stations.
n. Power transfer equipment.
o. Contactors.
p. Remote-controlled switches, dimmer modules, and control devices.
q. Battery-inverter units.
r. Battery racks.
s. Power-generating units.
t. Monitoring and control equipment.

END OF SECTION 26 05 33

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SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH 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.

B. Follow and comply with the SMSD MEP Electrical Standards.

1.2 SUMMARY

A. This Section includes computer-based, fault-current, overcurrent protective device coordination selective studies, and arc flash study. Protective devices shall be set based on results of the protective device coordination selective study.
   1. Coordination of series-rated devices is permitted where indicated on Drawings.
   2. Retain a qualified professional/engineering firm to assist in the development and implementation of the arc flash and protection coordination selective study.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-selective study specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.
   1. Coordination- selective study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   3. Coordination- Selective Study Report.
   4. Electrical One-line diagram

1.4 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- Selective 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, SMSD representative.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. The entity shall have an employee that is certified, train and skilled to perform this type of test and be able to interpret the curve and settings.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "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.

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 selective 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 Division 26 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. Switchgear and switchboard bus.
   2. Medium-voltage controller.
   3. Motor-control center.
   4. Distribution panelboard.
   5. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

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 141, IEEE 241 and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10.

b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.
e. IEEE C57.96.
2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium and high voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

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 SELECTIVE STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
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 141 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-Selective 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. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. 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.

3.5 ARC FLASH STUDY

A. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical systems studied. The calculations shall comply with NFPA-70E 2009, and IEEE-1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E and to provide a comprehensive software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Articles 130.1 and 130.3 for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.

B. The arc flash study shall determine the following results for each system mode of operation developed in Section 1.3E (Modeling). The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:
   1. Equipment name and voltage
   2. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
   3. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
   4. Equipment arc gap
   5. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
   6. Trip time, opening time, and total clearing time (total Arc time) of the protective device
   7. Worst-case arc flash boundary for each bus/equipment in the model
   8. Worst-case arc flash hazard incident energy in cal/cm^2 for each bus/equipment in the model
   9. Worst-case personal protective equipment (PPE) for each bus/equipment in the model

10. Working distances for up to five different distances showing items 7, 8, and 9 for each distance
11. Indicate “Danger/Hazardous” areas where incident energy is greater than 40 cal/cm2 and provide recommendations to reduced arc flash energy levels for these areas
12. Flag results where 85% arcing current provided worst-case results
13. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.

C. Contractor shall provide a detailed arc flash analysis report including as a minimum:
1. Introduction
2. Methodology
3. Information Sources
4. Assumptions including generic substitutions when data cannot be field verified. This type of assumptions shall be documented in the report.
5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.)
6. Arc Energy at 100% and reduced currents
7. IEEE 1584-2002 Considerations.
8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure.
9. Explanation of Data in Arc Flash Hazard Report Tables
10. NFPA 70E Information
    a. Shock Hazards with covers removed.
    b. Shock Hazard Approach Boundaries.
        1) Limited Approach Boundary
        2) Restricted Approach Boundary
        3) Prohibited Approach Boundary
    c. Arc Flash Hazard Boundaries
11. Results of Arc Flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
    a. Working distances.
    b. Energy Levels
    c. PPE Requirements
    d. Recommendations to reduce arc flash hazard energy and exposure.
12. Arc Flash Hazard Report
13. 3 Hard Copies
    a. 1 Electronic Copy in WORD or Excel format and PDF (5.0 or later)
    b. 1 Electronic copy in latest version of SKM format or its native software
14. Electronic file for Power System Modeling Software as developed and utilized for this analysis.

D. Contractor shall provide print labels for all equipment in the system from the project study file. Assume two (2) labels per equipment/bus in your estimate using 4" x 6" labels. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z 535. The labels shall be printable directly from the power system software utilized for the study.

E. The software shall provide complete integration of the one-line, database, short circuit and PDC and Arc flash functions. Software using separate short circuit, PDC, TCC or arc flash programs is not allowed. Spreadsheet calculations are not allowed. The purpose of this section is to ensure that the arc flash hazard calculations comply with NFPA-70E and IEEE-1584, and that the calculations are programmed with necessary requirements to help eliminate possible errors in the arc flash calculations. The additional purpose is to establish a detailed software model of the compliance with the OSHA requirements and NFPA 70E mandates. This model will serve

as an integral part of SMSD safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E Article 130.1(A)(2) for each electrical equipment in the facility.

1. Arc flash calculations shall be performed with enhanced IEEE-1584 equations, which eliminate voltage discontinuities and the non-conservative/average results of the standard equations. The purpose of this requirement is to ensure that the calculated incident energies are closer to actual test results insuring a conservative calculation minimizing personnel risk.
2. Arc flash calculations shall be based on the fastest clearing upstream protective device protecting the equipment for single sources and the slowest upstream protective device for multiple sources. The calculations shall automatically compare all series and parallel upstream protective devices in the system to determine the fastest series device or a conservative parallel clearing time.
3. The arc flash calculations shall include arc flash boundary, incident energy, PPE requirements, and working distances.
4. The arc flash calculations shall include calculations for all operating modes to ensure the worse arc flash magnitude.
5. The arc flash calculations shall provide integral “Work Tasks” for the listed equipment types. The tasks shall be derived from 70E Table 130.7(C)(9)(a) and be specific to the equipment type. Listed equipment types shall include:
   a. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 100-200 volt equipment.
   b. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 200-1000 volt equipment.
   c. Switchgear, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 1.0-5.0 kV equipment.
   d. Switchgear, MCC, VFD, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 5.0-15.0 kV equipment.
   e. Interrupting Switch, Conductor, and Open Air for 138 kV equipment.
6. Work Tasks shall have a user-defined library that provides the following customizable features for each work task:
   a. Work Tasks for each specific equipment type and voltage range
   b. Working distance units English or Metric
   c. Work distance for each task
   d. V-rated gloves and tool requirements
   e. Job description and procedures
   f. Safe work practices description
   g. Hazard Risk Category (HRC) reduction - HRC reduction can only be used based on a documented risk assessment as an integral part of a safety program.

END OF SECTION 26 05 73

SECTION 26 09 23 - 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.

B. Follow and comply with the SMSD MEP Electrical Standards.

1.2 SUMMARY

A. This Section includes the following lighting control devices:
1. Time switches.
2. Photoelectric switches.
3. Indoor occupancy sensors.
4. Lighting contactors.
5. Emergency shunt relays.

B. Related Sections include the following:
1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

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

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
1. Interconnection diagrams showing field-installed wiring.
2. Provide Settings requirements available from the Owner standpoint.
3. Provide the software that will support the lighting controllers.
4. Software must have the ability to detect outages or no power to a branch circuit and graphic indicators.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Intermatic, Inc.
   2. Leviton Mfg. Company Inc.
   3. Lightolier Controls; a Genlyte Company.
   4. Lithonia Lighting; Acuity Lighting Group, Inc.
   5. Watt Stopper (The).

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

C. Electromechanical-Dial Time Switches: Type complying with UL 917.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Intermatic, Inc.
   2. Lithonia Lighting; Acuity Lighting Group, Inc.
   3. Novitas, Inc.
   4. TORK.
   5. Watt Stopper (The).

2.3 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Lighting.
   2. Leviton Mfg. Company Inc.
   3. Lithonia Lighting; Acuity Lighting Group, Inc.
   4. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
   1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
   3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
   4. Mounting:
      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.

c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.4 OUTDOOR MOTION SENSORS (PIR)

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 comparable product by one of the following:
1. Bryant Electric; a Hubbell Company.
2. Hubbell Lighting.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Watt Stopper (The).

C. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as rain-tight according to UL 773A.
1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:
a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.

D. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.5 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. GE.
5. TORK.

B. Description: Electrically operated and mechanically held, combination type with non-fusible switch 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.
1. Monitoring: On-off status.
2. Control: On-off operation.

2.6 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: Multi-conductor 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: Multi-conductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 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 shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. All conductors shall be installed in an enclosed by a metal raceway.

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 luminaries 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. Perform the following field tests and inspections and prepare test reports:
   1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
   2. Operational Test: Verify operation of each lighting control device and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. 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."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 09 23

SECTION 26 09 43 - DIGITAL LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Digital Occupancy and Daylighting Sensor Control
   2. Emergency Lighting Control

B. Related Sections:
   1. Section [260926 – Lighting Control Panel Boards:] Lighting panels (switching) controlled by Digital Network Lighting Control System.
   2. Section [260936 – Modular Dimming Controls:] Digital Lighting Management
   3. Section [262726 - Wiring Devices:] Receptacles
   4. Section [265113 – Interior Lighting Fixtures, Lamps, and Ballasts:] Fluorescent electronic dimming ballasts.
   5. Section [25000 – Integrated Automation] Building integrator shall provide integration of the lighting control system with Building Automation Systems.
   6. Drawings and general provision of the Contact, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section
   7. Electrical Sections, including wiring devices, apply to the work of this Section.

C. Control Intent – Control Intent includes, but is not limited to:
   1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
   2. Initial sensor and switching zones
   3. Initial time switch settings
   4. Task lighting and receptacle controls
   5. Emergency Lighting control

1.2 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)

B. Underwriter Laboratories of Canada (ULC)

C. International Electrotechnical Commission (www.iec.ch)

D. International Organization for Standardization (ISO)

E. National Electrical Manufacturers Association (NEMA)

F. WD1 (R2005) - General Color Requirements for Wiring Devices.

G. Underwriters Laboratories, Inc. (UL) (www.ul.com):
   1. 916 – Energy Management Equipment.
   2. 924 – Emergency Lighting

1.3 SYSTEM DESCRIPTION & OPERATION

A. The Lighting Control and Automation system as defined under this section covers the following equipment:
   1. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relays controllers with **integral current thyristor**, 0-10 Volt control for ballasts.
   2. Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
   3. Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
   4. Digital Photosensors – Single-zone closed loop and multi-zone open loop daylighting sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylight harvesting.
   5. Configuration Tools – Handheld remote for room configuration provides two-way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send and receive of room variables and store of occupancy sensor settings. Computer software also customizes room settings.
   6. Handheld remotes for personal control – One-button dimming, two-button on/off, or five-button scene remotes provide control using infrared communications. Remote may be configured in the field to control selected loads or scenes without special tools.
   7. Digital Lighting Management (DLM) local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
   8. Network Bridge – provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS).
   9. Segment Manager – provides web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
   10. Emergency Lighting Control Unit (ELCU) – allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

1.4 SUBMITTALS

A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.

B. Shop Drawings:
   1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).
   2. Scale drawing for each area showing exact location of each sensor, room controller, and digital switch.

C. Product Data: Catalog sheets, specifications and installation instructions.

D. Include data for each device which:
   1. Indicates where sensor is proposed to be installed.
   2. Prove that the sensor is suitable for the proposed application.

1.5 QUALITY ASSURANCE

A. Manufacturer: Minimum [10] years' experience in manufacture of lighting controls. Provide list of (5) projects that have been complete for more than (1) year within 100 miles of new project location.

1.6 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 0° to 40° C (32° to 104° F).
   2. Relative humidity: Maximum 90 percent, non-condensing.

1.7 WARRANTY

A. Provide a five (5) year complete manufacturer's warranty on all products to be free of manufacturers' defects.

1.8 MAINTENANCE

A. Spare Parts:
   1. Provide 5 spares of each product listed below to be used for maintenance. Electrical contractor shall deliver items to SMSD maintenance within 30 days of substantial completion.
      a. Room Controllers
      b. Occupancy Sensors
      c. Emergency Bypass controllers
      d. Low voltage switches
      e. Daylighting harvesting photocells

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Listing of manufacturers does not constitute approval. Manufacturers listed still must comply with all specifications and no exceptions. Only manufacturers listed here or by addenda will be allowed if all Specification items are met. Line by line Specification compliance letter must accompany all requests for approval.

B. Acceptable Manufacturer:
   1. WattStopper (basis of design)

2.2 SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS

A. Type PW: Manual-ON, Automatic-OFF passive infrared (PIR) wall switch occupancy sensor Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper PW-100, PW-200, PW-103, PW-203, PW-301, PW-302, WS-301.

B. Type DW: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper DW-100, DW-200, DW-103, DW-203, DW-311, DSW-100, DSW-200, DW-103, DW-203, DSW-301, DSW-302.

2.3 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system

which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters. Passive infrared only sensors shall not be used for classroom applications.

B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
   1. Digital calibration and pushbutton programming for the following variables:
      a. Sensitivity – 0-100% in 10% increments
      b. Time delay – 1-30 minutes in 1 minute increments
      c. Test mode – Five second time delay
      d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
      e. Walk-through mode
      f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
   2. One or two RJ-45 port(s) for connection to DLM local network.
   3. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
   4. Device Status LEDs including:
      a. PIR Detection
      b. Ultrasonic detection
      c. Configuration mode
      d. Load binding
   5. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
   6. Manual override of controlled loads.

C. Units shall not have any dip switches or potentiometers for field settings.

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

E. All devices shall be hard wired. No wireless devices shall be permitted.

F. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC, LMPW, LMDW

2.4 DIGITAL WALL SWITCHES

A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening. Wall switches shall include the following features:
   1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
   2. Removable buttons for field replacement with engraved buttors and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
   3. Red configuration LED on each switch that blinks to indicate data transmission.
   4. Blue Load/Scene Status LED on each switch button with the following characteristics:
      a. Bi-level LED
      b. Dim locator level indicates power to switch

c. Bright status level indicates that load or scene is active

5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

B. Two RJ-45 ports for connection to DLM local network.

C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.

D. The following switch attributes may be changed or selected using a wireless configuration tool:

1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
2. Individual button function may be configured to Toggle, On only or Off only.
3. Individual scenes may be locked to prevent unauthorized change.
4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
5. Ramp rate may be adjusted for each dimmer switch.
6. Switch buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.

E. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

2.5 ROOM CONTROLLERS

A. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:

1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
3. Device Status LEDs to indicate:
   a. Data transmission
   b. Device has power
   c. Status for each load
   d. Configuration status
4. Quick installation features including:
   a. Standard junction box mounting
   b. Quick low voltage connections using standard RJ-45 patch cable
5. Plenum rated UL 2043
6. Manual override and LED indication for each load
7. Dual voltage (120/277 VAC, 60 Hz)
8. Zero cross circuitry for each load.

B. On/Off Room Controllers shall include:

1. One or two relay configuration

2. Efficient 150 mA switching power supply
3. Three RJ-45 DLM local network ports
4. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
   a. One relay configuration only
   b. Automatic-ON/OFF configuration
5. WattStopper product numbers: LMRC-101, LMRC-102, LMPL-101

C. On/Off/Dimming enhanced Room Controllers shall include:
1. Real time current monitoring
2. One, two or three relay configuration
3. Efficient 250 mA switching power supply
4. Four RJ-45 DLM local network ports.
5. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
6. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
7. The following dimming attributes may be changed or selected using a wireless configuration tool:
   a. Establish preset level for each load from 0-100%
   b. Set high and low trim for each load
   c. Set lamp burn in time for each load up to 100 hours
8. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMRC-221, LMRC-222, LMPL-201

2.6 DIGITAL PHOTO SENSORS

A. Digital photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space and are capable of controlling up to three lighting zones. Photosensors shall be interchangeable without the need for rewiring.

B. Digital photosensors include the following features:
1. An internal photodiode that measures only within the visible spectrum and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
2. Sensor light level range shall be from 1-10,000 footcandles (fc).
3. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
4. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the “ON Setpoint” and the “OFF Setpoint” that will prevent the lights from cycling after they turn off.
5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a user-selectable minimum level.
6. Optional programmable wall switch override to allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.

7. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
8. Red configuration LED that blinks to indicate data transmission.
9. Blue status LED indicates test mode, override mode and load binding.
10. Recessed switch to turn controlled load(s) ON and OFF.
11. One RJ-45 port for connection to DLM local network.
12. An adjustable head and a mounting bracket to accommodate multiple mounting methods and building materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.

C. Closed loop digital photosensors include the following additional features:
1. An internal photodiode that measures light in a 100° angle, cutting off the unwanted light from bright sources outside of this cone.
2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
3. Automatically establishes setpoints following self-calibration.
4. A sliding setpoint control algorithm for dimming daylight harvesting with a “Day Setpoint” and the “Night Setpoint” to prevent the lights from cycling.
5. WattStopper Product Number: LMLS-400.

D. Open loop digital photosensors include the following additional features:
1. An internal photodiode that measures light in a 60°angle cutting off the unwanted light from the interior of the room.
2. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.
3. A proportional control algorithm for dimming daylight harvesting with a “Setpoint” to be maintained during operation.
4. WattStopper Product Number: LMLS-500.

2.7 DIGITAL PARTITION CONTROLS

A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.

B. Four-button low voltage pushbutton switch for manual control.
1. Two-way infrared (IR) transceiver for use with configuration remote control.
2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
3. Configuration LED on each switch that blinks to indicate data transmission.
4. Each button represents one wall; Green button LED indicates status.
5. Two RJ-45 ports for connection to DLM local network.
6. WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening.

C. Coordinate contact closure interface for automatic control via input from Entertainment Networks Automatic Infrared Partition Sensor.
1. Operates on Class 2 power supplied by DLM local network.

2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
3. Input max. sink/source current: 1-5mA
4. Logic input signal voltage High: > 18VDC
5. Logic input signal voltage Low: < 2VDC
6. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
7. Two RJ-45 ports for connection to DLM local network.
8. WattStopper part number: LMIO-102

2.8 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
   1. 120/277 volts, 50/60 Hz., 20 amp ballast rating
   2. Push to test button
   3. Auxiliary contact for remote test or fire alarm system interface

B. WattStopper Product Numbers: ELCU-100, ELCU-200.

2.9 ROOM NETWORK (DLM LOCAL NETWORK)

A. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building. Digital room devices connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:
   1. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
   2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
   3. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
   4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

2.10 LIGHTING CONTROL PANELS

A. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

B. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 – 8 relays, 1 – 24 relays and 6 four-pole contactors, or 1 – 48 relays and 6 four-pole contactors.

C. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.

D. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:

1. Removable, plug-in terminal blocks with screwless connections for all low voltage terminations.
2. Individual terminal block, override pushbutton, and LED status light for each relay.
3. Direct wired switch inputs associated with each relay and group channel shall support two-wire, momentary or maintained contact switches.
4. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches, digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs, digital IO modules capable of receiving momentary or maintained contact closure inputs, digital photocell modules, and digital occupancy sensors.
5. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
6. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
7. Group, channel, and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override pushbuttons and LED displays for channels 1-9 or a handheld IR programmer for channels 1-99.
8. Relay group status for each channel shall be provided through red LED indicators for groups 1-9 and via BACnet for groups 1-99. Solid red indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
9. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
10. Electrical:
    a. 30 amp ballast at 277V
    b. 20 amp ballast at 347V
    c. 20 amp tungsten at 120V
    d. 30 amp resistive at 347V
    e. 1.5 HP motor at 120V
    f. 14,000 amp short circuit current rating (SCCR) at 347V
    g. Relays shall be specifically UL listed for control of plug loads
11. Mechanical:
    a. Individually replaceable, ½” KO mounting with removable Class 2 wire harness.
    b. Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
    c. Dual line and load terminals each support two #14 – #12 solid or stranded conductors.
    d. Tested to 300,000 mechanical on/off cycles.
    e. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
12. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

13. Lighting control panels shall be WattStopper model LMCP8, LMCP24 or LMCP48 as shown on the plans.

2.11 BACNET® BASED DIGITAL COMMUNICATIONS

A. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 master/slave token passing-based using the BACnet® protocol.

B. The panel shall have provision for an individual BACnet device ID. The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.

C. The panel shall support MS/TP MAC addresses in the range of 0 – 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.

D. Lighting control relays shall be controllable as binary output objects in the instance range of 1 – 64. The state of each relay shall be readable and writable by the BAS via the object present value property.

E. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 – 64.

F. The 99 channel groups associated with the panel shall be represented by binary value objects in the instance range of 201 – 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.

G. Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:

1. Binary output objects in the instance range of 1 – 64 (one per relay) for on/off control of relays.
2. Binary value objects in the instance range of 1 – 99 (one per channel) for normal hours/after hours schedule control.
3. Binary input objects in the instance range of 1 – 64 (one per relay) for reading true on/off state of the relays.
4. Analog value objects in the instance range of 1 – 64 (one per relay) shall assign relays to channel groups in the range of 1 – 99.
5. Analog value objects in the instance range of 101 – 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
6. Analog value objects in the instance range of 201 – 299 (one per channel) shall assign an after-hours time delay value to the channel in the range of 1 – 240 minutes.
7. Multi-state value objects in the instance range of 1 – 99 (one per channel) shall provide the state of the relays assigned to the channel. Valid states shall be ALL ON, MIXED, BLINK, and ALL OFF.

a. The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
b. The BO and BV 1 – 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (http://www.bacnet.org/Addenda/Add-135-2010aa.pdf)
c. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
d. Lockout of all digital switch buttons connected to a given panel shall be commandable via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.
e. Lighting control accessory devices connected to the panel shall be represented via BACnet objects including but not limited to the following:
f. Digital occupancy sensor detection states shall be readable as BI objects ranging from BI1-96.
g. Digital occupancy sensor configuration parameters shall each be accessible as BACnet objects when applicable to a given product.
h. Occupancy sensor time delay in minutes shall be writeable via AV101-196.
i. Occupancy sensor passive infrared (PIR) sensitivity percentage shall be writeable via AV201-296.
j. Occupancy sensor ultrasonic (US) sensitivity percentage shall be writeable via AV301-396.
k. Digital switch buttons shall be readable and writeable as BI objects ranging from BI101 – 9608.
l. Digital daylight sensors foot-candle readings shall be readable as follows:
m. Analog 0-5V/0-10V sensors connected to a digital input module shall be represented as AI1-96.
n. Digital closed loop sensors shall be represented as AI4001-4096.
o. Digital open loop sensors shall be represented as AI5001-5096.
p. Digital dual loop sensors shall be represented as follows:
q. The upward facing open loop sensor shall be represented as AI6001-6096.
r. The downward facing closed loop sensor shall be represented as AI6101-6196.
s. Digital daylight sensor configuration shall be exposed as BACnet objects as follows:
t. Digital closed loop sensors shall be represented as follows:
u. Daylight Sensor Day Setpoint (ftcd) AV4201-4296.
v. Daylight Sensor Night Setpoint (ftcd) AV4301-4396.
w. Daylight Sensor Off Setpoint Delay (minutes) AV4401-4496.
x. Daylight Sensor On Setpoint (ftcd) AV4501-4596.
y. Daylight Sensor Off Setpoint (ftcd) AV4601-4696.

2.12 USER INTERFACE

A. Each lighting control panel system shall be supplied with at least (1) handheld IR remote programming interface consisting of a keypad and associated OLED display screen. The user interface shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following functions as a minimum:

B. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.

C. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.

D. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.

E. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.

F. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.

G. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minmum LAT, LON, DST zone, and an approximate city/state location.

H. An additional handheld IR remote may optionally be specified to be permanently mounted to the panel interior via a retractable anti-theft lanyard to allow for convenient programming of the panel while assuring that the handheld programmer is always present at that panel. An unlimited number of handheld IR remotes may also be purchased for facilities staff as seen fit by the end user's representative.

2.13 CONFIGURATIONS TOOLS

A. A configuration tool facilitates optional customization of DLM local networks and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface.

B. Features and functionality of the wireless configuration tool shall include:
   1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
   2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
   3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
   4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
   5. Temporarily adjust light level of any load(s)on the local network, and incorporate those levels in scene setting.
   6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

C. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

2.14 WIRELESS NETWORK BRIDGES AND BORDER ROUTER

A. Wireless Network Bridges connect to a DLM local network (room) and use IEEE 802.15.4 6LoWPAN for communication between rooms and to a Border Router that oversees the formation and configuration of the wireless network. Each local network shall include a wireless network bridge that connects to the other DLM devices on the local network, and a group of Wireless Bridges shall connect to a Border Router.

B. Features of the Wireless Network Bridges shall be as follows:

1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
2. Wireless Bridges provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the Border Router via the wireless network. No commissioning shall be required for set up of the network bridge on the local network.
3. Wireless Bridges shall incorporate dual internal omni-directional antennas with diversity to provide wide and robust communication, and so the antennas will be protected against accidental contact with other objects in the space.
4. Two LEDs shall be included on the bridge to provide feedback about the local network (red) and wireless network (blue) health.
5. Wireless Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID per room are not acceptable. Standard BACnet objects shall be provided as follows:
   a. **Read/write the normal or after hours schedule state for the room**
   a. Read the detection state of each occupancy sensor
   b. Read the aggregate occupancy state of the room
   c. Read/write the On/Off state of loads
   d. Read/write the dimmed light level of loads
   e. Read the button states of switches
   f. Read total current in amps, and total power in watts through the load controller
   g. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
   h. Activate a preset scene for the room
   i. Read/write daylight sensor fade time and day and night setpoints
   j. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
   k. Set daylight sensor operating mode
   l. Read/write wall switch lock status
   m. Read watts per square foot for the entire controlled room
   n. Write maximum light level per load for demand response mode
   o. Read/write activation of demand response mode for the room
   p. Activate/restore demand response mode for the room

C. Features of the Wireless Border Router shall be:

1. The Wireless Border Router shall manage the formation and configuration of the 6LoWPAN wireless mesh network and provide connectivity via wired 10/100 Ethernet to

a local area network that may include a LMSM Segment Manager or Building BAS System.

2. Border Router shall provide key information about the health of the mesh network in the form of signal quality, device status, network status, and other real-time network information such as energy monitoring.
3. The LMBR-600 shall have dual internal omni-directional antennas with diversity to ensure reliable communication with Wireless Network Bridges and provide a user interface for set up and configuration.
4. Include an internal MicroSD card and a Real-time clock with supercap back-up. Border Router shall get power for operation via a 120V outlet (in non-plenum applications) and a dedicated DLM LMPB-100 Power Booster connected to a Cat 5e to DC barrel connector (for plenum applications).

D. Communication between the Wireless Network Bridges and the Border Router
1. The communication between the Wireless Bridges and the Border Router shall be via a standalone wireless mesh network that does not require interface with any other wireless network in the space. The mesh network shall allow communication between all rooms as long as they are within 100' of another connected room.
2. The Wireless Bridges shall communicate over a 6LoWPAN 2.4 GHz IEEE 802.15.4 network and use AES 128-bit Key Encryption for network security.
3. In addition to IEEE IPV6, the Border Router shall have available Constrained Application Protocol (CoAP), Routing Protocol for Low Power Networks (RPL), and Stateless Multicast RPL Forwarding (SMRF).
4. The wireless protocol shall allow BACnet communication to be transported transparently between the Network Bridge and any front-end BAS devices such as the LMSM Segment Manager.

E. WattStopper product numbers: Wireless Network Bridge LMBC-600, Wireless Border Router LMBR-600.

2.15 MANAGER

A. The Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall serve up a graphical user interface via a standard web browser. Each segment manager shall have support for one, two or three segment networks as required and allow for control of a maximum of 40 local networks (rooms) and/or lighting control panels per segment network.

B. Operational features of the Segment Manager shall include the following:
1. Connection to PC or LAN via standard Ethernet TCP/IP.
2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser.
3. Log in security capable of restricting some users to view-only or other limited operations.
4. Automatic discovery of all DLM devices on the segment network(s). Commissioning beyond activation of the discovery function shall not be required.
5. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
6. Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation.
7. Ability to set up schedules for rooms and panels. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation.

8. Ability to group rooms and loads for common control by schedules, switches or network commands.
9. Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature.

C. Provide seamless integration with the BAS via BACnet IP. Provide export table with available parameters.

2.16 REMOTE ACCESS AND ENHANCED WARRANTY FOR NETWORKED LIGHTING CONTROL SYSTEMS

A. The manufacturer of the Lighting Control System shall provide a complete combination of hardware, software, and cellular subscription to enable a complete solution to allow the manufacturer remote access to the lighting control system. Configuration to include at a minimum: cellular modem, antenna for the modem, cellular service contract and any connections required to enable communication to the specified Network Lighting Control system.

B. The Remote Access capability shall provide at a minimum the following features:
1. Ability to provide initial system diagnostics through LMCS Software to detect fault conditions in hardware or connected devices.
2. Access to all devices via LMCS Software allowing for complete programmability of every feature of every device. This will include all scheduling of Time of Day Events and programming of individual device parameters to meet Sequence of Operation requirements.
3. Access to the LMSM Segment Manager browser-based interface (if included on project) to check that it's been set up as specified in project documentation, and all functional operations are working properly.
4. On demand access to manufacturer technical support via a Remote Operations Center that can provide remote troubleshooting, diagnostics, and configuration/programming assistance.
5. Client Training on the Lighting Control System can be performed while remotely connected to the site.

C. All subscription costs for the Cellular signal required for the Remote Modem shall be borne by the controls manufacturer for the first year. Cellular modem shall provide secured access to the site, so that access is only enabled if requested by the electrical contractor or the customer for a minimal period. Systems that allow the modem to be always accessible will not be acceptable. Access must be by a secured VPN connection to the private lighting control network that is completely isolated from the customer's internal network. Remote access that requires a connection through the customer's internal network will not be acceptable.

D. Inclusion of the Remote Access program on a project will automatically trigger a 1st year Enhanced Warranty agreement for the site that will start once project startup is complete and run for one year. During this period the site contact can request the manufacturer to check the system for proper operation, and make any programmable changes desired by the customer. Manufacturer must provide a phone number dedicated to customer calls concerning Remote Accessible systems, and a support organization capable of enabling cellular communication to the system for troubleshooting and making requested changes to the system. Any user attempting to request remote support on the system shall be fully verified by the Remote Operations Center before providing remote support or making any changes to the system.

E. If the customer does not continue the enhanced warranty the cellular contract will lapse, and all hardware components, while still remaining property of the manufacturer, will remain in situ so that they can be re-activated at a later time should the customer desire.

F. At initial bid time provide line item pricing option to extend enhanced warranty period for a total of 5 years.

2.17 EXTERIOR WIRELESS LIGHTING CONTROLS - GENERAL

A. System: Provide WattStopper / Legrand, Exterior Wireless Lighting Controls for exterior lighting indicated on the Drawings and specified in Section 26 56 33 - Walkway Lighting [26 56 00].

B. Description: WattStopper Wireless Network consists of WattStopper radio frequency (RF) controllers (nodes) communicating with Wireless Network Managers, and optional Servers to consolidate Wireless Network Managers into a single interface. The Network includes software applications for secure management, control and monitoring of the nodes, a database of control and operational data, and a web interface designed to display operational data and interface with individual units in a network of controls.

C. Operating Sequence:
   1. Automatic Operation (Dimming):

D. Ratings: Ratings shall be as listed for each control individually.

E. Network Controls: WattStopper network shall consist of a series of WattStopper wireless lighting and I/O controls communicating with each other over a wireless IP network, WattStopper dimming control modules interfacing with fixtures and dimming drivers, and WattStopper Wireless Network Managers that communicates with a single web based Central Management System (CMS). The wireless network will support two (2) types of wireless devices:
   1. Twist lock dimming controls (NWTL-111)
      a. 30 to 1,000 watts.
      b. 100-480 volts AC
      c. Input - dry contact closure from any 3 wire WattStopper sensor
      d. 24 VDC Power source for low voltage sensors
      e. Complies with ANSI C136 .10.
      f. Collects data from the Node, then sends data wirelessly to Wireless Network Server.
      g. Average power consumption under 2 watts.
      h. Minus 40 to 70 degrees C; up to 90 degrees C interface per ANSI; base rated at 120 degrees C.
      i. Wirelessly interfaces with the Wireless Network Manager.
   2. I/O Modules
      a. For connection of motion, photo or other sensors, and switches to the wireless network.
      b. 4, 12 and 24 I/O configuration.
      c. Catalog numbers -WIO-4UI, WIO-4DI, WIO-4, WIO-12, WIO-24.
      d. NEMA 4 (weatherproof) models include WIO-4WP and WIO-6WP.
   3. Control
      a. Remote on/off control.
      b. Grouped scheduling (energy savings).

c. Dimming control modules shall include individual and group control.
d. Dimming module provides wireless dimming control for any fixture with 0 to 10V dimming ballast/driver.

4. Wireless enabled communication.
   a. 2.4 GHz -802.15 .4 compatible.
   b. FCC Part 15 approved.
   c. 1,000 foot clear line of sight.
   d. Self-healing tree network with repeating Nodes.
5. Compatible with 0-10V dimming ballasts.
   a. Voltage 72-305 VAC; 320J MOV -9500 A surge protection.
   b. Average power consumption of 1.4 watts.
   c. Maximum power consumption of 2.2 watts.
   d. Dimming control module shall operate in minus 40 to plus 70 degrees C ambient temperatures.
6. Control
   a. Remote continuous dimming control.
   b. Momentary contacts.
   c. Lights Automatic.
   d. Lights 100 percent.
   e. Lights Off.

F. Accessories:
1. Antenna mounts and cables for radio operation.
2. Wireless Network Managers shall be preconfigured to connect to the Wireless Network Server and require no explicit configuration.
3. Wireless Network Managers shall include the following features:
   a. Synchronizes wireless network and manages Node time.
   b. Receives inputs and executes individual and group commands.
   c. Overrides local schedules for event planning.
   d. Stores Node historical data.
   e. Transmits node data back to Wireless Network Server.
   f. Wireless 2.4 GHz - 802 .15.4 Control Network.
      1) FCC Part 15 approved.
      2) 1,000 foot clear line of sight.
      3) Supports up to 200 nodes.
   g. Cellular Communications Network.
      1) GSM, GPRS, CDMA, modem; Ethernet link for optional WAN connection via the internet.
   h. WiFi Network - 802.11N.
   i. General
      1) 320J MOV - 6,500 amp surge protection.
      2) Voltage 100-130 VAC.
      3) Wireless Network Server shall operate in minus 40 to plus 70 degrees C ambient temperatures.
      4) System shall be scalable and capable of supporting networks of varying size.
      5) All servers in the Wireless Network Server shall use the NTP protocol to ensure that their clocks are in sync.

G. Software:
1. WattStopper Wireless Network shall interface with a network capable of displaying data collected.
2. WattStopper Network shall interface with a web portal providing remote user control over elements within the network.
3. Web portal shall include the following functions and control views:
   a. Function - a Scripting engine that assists in automating tasks such as commissioning or reporting.
   b. Settings - A configuration tool to enable applications, communications, ports, email, and protocols.
   c. Users - to add access rights such as settings, help, alarm, eqipm, graphics, history, notes, reports, and schedule access for specific user accounts.
   d. Debug - a trouble shooting, logging and reporting tool to manage the scripting functions.
   e. Help - Online, content sensitive assistance.
   f. Alarm - Reporting tool for alarms, can print, email or text alarm conditions.
   g. Builder - A database builder that imports all available connections and allows the selection of sensors and control points to be integrated into the system for monitoring and control.
   h. Connectors - A configuration too to enable multiple protocols to be enabled, configured and managed.
   i. Control - A user interface for setting up control logic including scheduling and Inputs / Output relationships and sequences of operation.
   j. Energy - A energy reporting tool using Power, Energy and rate structures for analyzing energy use and costs.
   k. Equipment - A tool used to organize sensors and control points associated with a piece of equipment or room.
   l. Graphics - A tool for visualizing data. Can be used with mapping programs or CAD drawings to display loads or sensors.
   m. Historian - A time based visualization tool to view one or multiple data points from any device connected to the network.
   n. Job - An automation tool for synchronizing systems or performing automated tasks on a scheduled basis.
   o. KPI - A visualization tool that compares building or system performance against user defined Key Performance Indexes.
   p. Note - A tool used to communicate additional information about a device or area, can be used in troubleshooting or system maintenance.
   q. Reports - Standard and customized information organized to meet the customers' requirements for specific period performance.
   r. Schedule - Standard time based, astronomic and holiday schedules for control system operation.
   s. Weather - a link to weather stations to bring in information from outside weather sources including sunrise/sunset times, temperatures, humidity, sunlight levels and other relevant weather data.
4. Dashboard view shall summarize the status of all Nodes, and Wireless Network Managers within the network:
   a. Users shall be able to quickly determine the operational status of all Nodes within the system.
   b. Users shall be able to export status data.
   c. Users shall be able to print status data in a format conducive to presentation.

d. Users shall be able to request additional information about abnormal operations within the system.
   1) Users shall be able to see basic information about malfunctions.
   2) Users shall be able to see the location of each malfunctioning device Users shall be able to see a seven day history of each device.
   3) Users with appropriate permissions shall be able to create work orders.
   4) The Map view shall provide a geographical representation of system assets.
e. Users shall be able to navigate around the map using standard navigational constructs.
f. Users shall be able to determine which assets are operating normally and which ones are malfunctioning in some way based on the icons used to represent each fixture.
g. Users with appropriate permissions shall be able to relocate a fixture from within the Map view.
h. Users with appropriate permissions shall be able to add or view notes about a fixture from within the Map view.
i. Users with appropriate permissions shall be able to view or edit the attributes collected about each fixture during node activation from within the Map view.
j. Users with appropriate permissions shall be able to issue the following commands to fixtures from within the Map view.
   1) Turn on or off for x time, x not to exceed one day.
   2) Turn on or off until y time, y not to exceed one day. Return to normal operation.
   3) Dim to x level for y time, x ranging from 0-100 and y not to exceed one day
k. Users with appropriate permissions shall be able to issue commands to groups as well as individual units within the system.
l. Users with appropriate permissions shall be able to create work orders from within the Map view.
m. All users shall have read only access to the information on the Map view regardless of permissions.
n. History view shall provide historical data for all fixtures.
   1) History shall be available for either seven days or thirty days.
   2) History view shall include filters that focus attention on specific assets or operational conditions.
o. History view shall include daily and hourly data for each fixture in the system. Data shall be available in both report and graphical formats.

5. Grouping view shall enable users to interact with units within the network as a single group:
   a. Users shall be able to define a subset of units on the network as a group from within the Grouping view.
   b. Users shall be able to name each group from within the Grouping view.
   c. Users shall be able to add additional nodes to a group from within the Grouping view.
   d. Users shall be able to remove devices from a group from within the Grouping view.
   e. Users shall be able to view information about the status of all devices within a group from the Grouping view.
   f. Status information displayed in the Grouping view shall use the same format as the same information within the Dashboard view.
6. Scheduling view shall enable users to schedule commands:
   a. Users shall be able to define schedules from within the Scheduling view.

b. Users shall be able to issue schedules from within the Scheduling view.
c. Users shall be able to define events from within the Scheduling view.
d. Users shall be able to issue events from within the Scheduling view.
e. The Scheduling view shall recognize and use groups defined within the Grouping view.
f. Events shall take priority over Node schedules if both are in place for the same units at the same time.

H. Networking:
1. Nodes within the network shall be capable of remote turn off and turn on.
2. Nodes within the network shall be capable of assignment to groups which can be controlled over the network as a single unit.
3. Nodes within the network shall communicate with neighbor controls and Wireless Network Manager devices via Gigahertz radio signals within a network.
4. Nodes within the network shall have a communications range of 1,000 feet between devices.
5. Communications between controls are optimized with a direct line of sight.
6. Historical data shall have an adjustable collection interval resolution starting at one minute.
7. Data sent from individual controls via radio signals shall be encrypted
8. Data sent from the Wireless Network Manager to the Wireless Network Server shall be encrypted.
9. Nodes within the network shall provide troubleshooting information over the network in the form of alarms:
   a. All troubleshooting reports shall include the MAC number of the associated photocontrol.
   b. Fixture malfunctions shall be reported.
   c. Cycling fixtures shall be reported.
   d. Day burning fixtures shall be reported.
   e. Uncommunicative photo controls shall be reported.
   f. Power details for fixtures shall be reported.
   g. Photo control within the network shall operate as a standard standalone photocontrol if networking fails.
   h. Performance of scheduled operations shall continue while in standalone mode.
10. No node within an installation shall be a communications bottleneck. If any control within an installation is unavailable for communication for any reason, the signal shall be sent via different path.
11. Daily data collation shall run from midnight to midnight each night.

I. Monitoring:
1. System shall monitor the following:
   a. Remote Monitoring and Diagnostics
   b. Fixture Malfunction
   c. Cycling
   d. Day-burner
   e. Unspecified Malfunction
   f. No Communication
   g. No power
   h. Low System Voltage

i. High System Voltage
j. High V Delta
k. Low Wattage
l. Excessive Power Use
m. Fixture on a Group Control

2. System shall provide runtime charts (bar or line) and allow comparison of variables against similar devices (voltage, watts, amps, etc.).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor shall provide to the manufacturer all quantities for system including but not limited to relays, room controllers, relay panels, plug load controllers, switches, sensors and wire lengths and configurations for both network and device cable at least 1 week before bid.

B. When using wire for connections other than the DLM local network (Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements

C. All MSTP network and Cat 5e low voltage wiring must have “WattStopper” printed on the wire jacket. Any cable substitutions shall be removed and replaced at the contractor’s expense.

D. All MSTP network terminations shall utilize wire ferrules for terminations and MSTP network manufacturer’s instructions. Any network deficiencies shall be repaired at the contractor’s expense.

E. Electrical contractor must provide a detailed as-built plan in CAD showing MSTP network cable routing and network bridge serial numbers to the manufacturer at least 3 weeks prior to factory commissioning Install the work of this Section in accordance with manufacturer’s printed instructions unless otherwise indicated.

F. Electrical contractor shall be responsible for scheduling the following onsite coordination meetings through the duration of the project. Attendance shall be required for the GC, EC, representative from MEP firm, BAS Integrator and lighting control rep.
   1. Pre-Installation- After submittals have been approved and material has arrived onsite and before installation of any devices begins. Review lighting control layout plans, required as-built information, and MSTP Terminations.
   2. Pre-Factory startup- Electrical contractor must have all lighting control devices installed, wired and tested at least 90 days prior to substantial completion deadline. At this coordination meeting the electrical contractor shall walk the site with attendees and go room by room to ensure they are ready for factory technician to start the system programming. Electrical contractor shall have his as built documentation of the system completed for this meeting.
   3. Move in- 30 days prior to owner move in all parties shall meet onsite to review completed system. At this time all installation and factory programming shall be completed.

3.2 FACTORY COMMISSIONING (OPTIONAL)

A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

B. The factory commissioning shall include the following services. Programming of all button stations, configuration of all occupancy sensors and photocells. Verification of a complete and working system including MSTP network status. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
   3. Load Parameters (e.g. blink warning, etc.)

C. The electrical contractor shall request factory commissioning by submitting a startup request form at least (4) weeks before startup is required.

D. Electrical contractor must schedule lighting control factory start-up to begin at <u>least 60 days prior to substantial completion deadline.</u>

E. Lighting control technician shall issue daily reports notifying of the project status, open issues, challenges, etc. at the end of each day he/ she is onsite commissioning the system. Reports shall be sent directly to EC, GC and Engineer.

F. At the completion of the first visit of the lighting control technician, all parties shall meet onsite to walk the project and evaluate any open issues. At this meeting the schedule for owner training shall be determined.

G. The electrical contractor shall provide at least (1) journeyman electrician, familiar with the installation of the system, dedicated to assisting the factory start-up technician for the entire duration of the commissioning process.

H. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

I. Re-commissioning – After 90 days from occupancy the factory authorized representative and electrical contractor shall re-calibrate all sensor time delays and sensitivities to meet the Owner’s Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity

J. Owner operation memo- Lighting control manufacturer shall prepare an operational memo for owner to distribute informing building occupants of the operation of their lighting control system. Memo shall explain the following but not limited to: auto on/ vs manual on, occupancy sensors, daylight harvesting, plug load control, after hours time delays.

END OF SECTION 26 09 43

SECTION 26 11 00 - FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of Division 16 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section.

1.2 SECTION INCLUDES

A. Fireproof fire stopping materials.

1.3 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

A. Fireproof fire stopping materials.

B. Provide U.L. category and file numbers of products.

1.4 QUALITY ASSURANCE: COMPLY WITH THE FOLLOWING.

A. ASTM E814 (UL 1479) - Test Method of Fire Tests of Through-Penetration Fire stops.

B. NEC 300-21 and NEC 800-52(b).

C. Conform to applicable code for fire resistance ratings and surface burning characteristics.

D. Provide certificate of compliance from authority having jurisdiction indicating approval of combustibility.

1.5 SEQUENCING

A. Sequence work to permit fire stopping materials to be installed after adjacent and surrounding work is complete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Flame-Safe FS500, FST600, FS900, FST900, or FSP1000.

B. Dow Corning 306548 Silicone RTV Foam.

C. 3M Fire Barrier Penetration Sealing Systems.

D. PENSIL 851, General Electric Company.

2.2 PERFORMANCE REQUIREMENTS

A. The requirements of this section shall be provided in addition to the requirements of Division 7.

B. Maintain required classification, fire, acoustic, and vapor barrier ratings for electrical installations penetrating walls, ceilings, and floors per ASTM E814 (UL 1479), NEC 300-21 and NEC 800-52(b).

1. Penetrations of classified area walls, ceiling and floors shall be sealed with the same material to maintain the integrity of area classification.
2. Penetrations of fire-rated walls, ceilings, and floors shall be sealed with a UL listed Through-Penetrations Fire-Stop System.
3. Penetrations of non-fire-rated walls, ceilings, and floors shall be filled and finished using the same finish material as the wall, ceiling, or floor.
4. Outlet box and lighting fixture installation in fire-rated walls, ceilings, and floors shall be in accordance with the UL Fire Resistance Directory.

C. Fire safety system shall not require de-rating the ampacity of electrical conductors.

D. Where mastic is used to seal the surface of the fire stop, the mastic shall be non-hardening.

E. Fire safety material shall not contract to allow transmission of smoke or water prior to exposure of a fire condition.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter which may affect bond of fire stopping material.

B. Remove incompatible materials which affect bond.

3.3 APPLICATION

A. Apply primer and materials in accordance with manufacturer's instructions.

B. Apply fire stopping material in sufficient thickness to achieve rating to uniform density and texture.

C. Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit, and other items requiring fire stopping.

D. Sleeves shall be of suitable length to accommodate fire stopping system used. Where conduit passes through a sleeve, the clearance around the conduit shall not be less than 1/2".

3.4 CLEANING

A. Clean adjacent surfaces of fire stopping materials.

3.5 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 26 11 00

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SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Harmonics Mitigating (Canceling) Transformers as indicated on Drawings:
      a. Delta-to-ZigZag 0-degree phase shift secondary.
      b. Wye-to-ZigZag 30-degree phase shift secondary.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Coordination Drawings: Provide coordination drawings as described in 26 05 00 paragraph 1.03(C).

C. 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.

D. Qualification Data: For testing agency.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

D. Harmonics Canceling Transformers: NEMA ST-1, TP-1, TP-2 and IEEE-519-1992 compliance.

E. Comply with United States Department of Energy (DOE), United States Code (USC) and Code of Federal Regulations (CFR)
   1. 42 USC - Energy Conservation Program for Consumer Products Other Than Automobiles

2. 10 CFR 431 – Energy Efficiency Program for Certain Commercial and Industrial Equipment, Subpart K – Distribution Transformers
3. Appendix A to Subpart K of 10 CFR part 431 - Uniform Test Method for Measuring the Energy Consumption of Distribution Transformers

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General Purpose Dry-Type: Subject to compliance with requirements, provide products by one of the following:
1. Square D / Schneider Electric
2. Siemens
1. Eaton / Cutler Hammer

B. General Purpose Dry-Type: Subject to compliance with requirements, provide products by one of the following:
1. Powersmiths T1000-30H
2. Power Quality International
3. Mirus
3.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper, unless indicated otherwise in Drawings.
3. Core and coil designs shall be low loss type with minimum efficiencies per NEMA TP1 and 10 CFR §431.196(a)(2) (DOE 2016 requirements) when operated at 35% of full load capacity. Efficiency shall be tested in accordance with NEMA TP2 and 10 CFR §431.193.

D. Enclosures: NEMA 2 or 3R rating as required, unless otherwise indicated on Drawings.
1. Provide hinged doors with infrared scanning window.
2. Provide surge protection device (SPD).

3. Provide compression lug kit for all terminations.

E. Efficiencies:

Single phase		Three Phase	
kVA	Efficiency	kVA	Efficiency
15	97.7%	15	97.89%
25	98.0%	30	98.23%
37.5	98.2%	45	98.40%
50	98.3%	75	98.60%
75	98.5%	112.5	98.74%
100	98.6%	150	98.83%
167	98.7%	225	98.94%
250	98.8%	300	99.02%
333	98.9%	500	99.14%
		750	99.23%
		1000	99.28%

2.3 HARMONIC MITIGATING TRANSFORMERS

A. Single Output (Secondary):
1. DZ0 – Delta Primary, Zig-Zag Secondary, 0° phase shift.
2. YZ30 – Wye Primary (ungrounded neutral), Zig-Zag Secondary, 30° phase shift.

B. Insulation and Varnish systems: 220 deg. C. Class R, Epoxy polyester impregnation, 130°C Temperature Rise in 40°C Ambient.

C. All terminals. Including those for changing taps, must be readily accessible. Windings shall be continuous with terminations brazed or welded. 10KV BIL.

D. Compatible with all types of linear and non-linear current and future loads.

E. Impedance: Between 3.0% and 5.0% at rated KVA.

F. Zero sequence Impedance/reactance less than 0.95% and 0.3% respectively.

G. Zero sequence currents not coupled into primary windings.

H. Voltage Taps: Two (2) 2.5% above and four (4) 2.5% below nominal primary voltage.

I. Provide dual electrostatic shield.

2.4 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One (1) leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Taps for Transformers Smaller than 3 kVA: None.

E. Taps for Transformers 7.5 to 10 kVA: Two (2) 5 percent taps below rated voltage.

F. Taps for Transformers 15 kVA and Larger: Two (2) 2.5 percent taps above and four (4) 2.5 percent taps below normal full capacity.

G. Insulation Class: Class R (220 deg C), UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

H. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

I. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
   2. Indicate value of K-factor on transformer nameplate.

J. Wall Brackets: Manufacturer's standard brackets.

K. Fungus Proofing: Permanent fungicidal treatment for coil and core.

L. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

M. Low-Sound-Level Requirements: Maximum sound levels, when factory tested, shall be in according to IEEE C57.12.91.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

C. Testing will also include recording of the voltages on the primary and secondary including the Impedance used.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions. Working Clearance shall not be less than 4 feet in front of the front cover. Inform engineer if there is a potential clearance problem prior to rough-in.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer. Install a ground copper bar for all grounding connections. Single lug grounding is not permissible.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

F. Grounding electrode conductor will be installed in conduit and connected with Blackburn clamps. A connection will be made to building steel and a new driven copper ground rod.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer. If ceiling mounting is utilized, a letter shall be obtained and approved by a structural engineer.
   1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.

C. Install ALL floor mounted transformers as indicated on 6” housekeeping pads 4” inches larger than transformer, complying with manufacturer's written instructions, applicable requirements of NEC, NESC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements. Provide NEC working clearance in front of transformers assuming they will require examination while energized.

D. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

E. Install floor mounted units with bolts to equipment pad with neoprene/cork vibration mounts between transformer and pad. Comply with manufacturer's indicated installation method, if any.

F. Connect transformer units to electrical wiring system with flexible metal conduit or liquid tight flexible metal conduit. Comply with the requirements of other Division 16 sections.

G. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL STD 486A. Record torques on all terminations.

H. Back off shipping bolts on internal vibration isolators.

I. Provide complementary 0° and 30° phase-shift in as equal capacities for each bus as possible to maximize harmonic mitigation.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems." Install a ground copper bar to where all connections are made. Do not use single lugs. The GEC conductor shall be installed directly to XO terminal. Use grounding bushing. Follow SMSD –MEP Electrical Standards

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Carefully remove the wire insulation without damaging the copper wire strands and check all connections are to be tight.

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.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Infrared (Baseline) Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
   1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
   2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
   3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

G. Provide equipment grounding connections for power/distribution transformers, sizes per NEC. Tighten connections to comply with tightening torques specified in UL STD 486A to assure permanent and effective grounding.

H. Transformer Testing
   1. Certified Test Reports in accordance with TP-1-2002 and TP-2.
   2. Open Circuit transformer tests, for calculating percent zero-sequence impedances and reactance as follows:
      a. With the transformer's primary terminals open-circuited, make a low impedance connection between secondary Terminals X1, X2 and X3.
      b. Connect a variable 60HZ power source between Secondary Terminals X1, X2, X3 and X0, which includes precision revenue class voltage and current measurement instrumentation.
      c. Increase 60HZ voltage across Terminals X1, X2, X3 and Terminal X0 until >2/3 full-scale readings are obtained on the voltage and current meters. In no case can the current reading exceed the full load rating of the winding under test. The values may be lower since impedance and reactance are linear.
      d. Calculate impedance in Ohms based on the measured voltage and current values.
      e. Based on the measured voltage, as a percentage of the rated voltage of the windings, calculate percent zero-sequence impedance and reactance.

3. Closed Circuit Transformer Tests, for calculating transformer core and copper losses as follows:
   a. In accordance with e-Rated Transformer Corporation Standard Publications VAD1-2003 and VAD2- 2003.
   b. Measure Primary and Secondary voltage and current differences simultaneously, using 'revenue class' instrumentation and calculate excitation or no-load losses and impedances/load losses.
   c. Submit such reports as part of shop drawings submittals for each size typical transformers, based on tests done within a year or less time.
   d. Submit such reports for all the transformers for the project, prior to shipment.
4. Design, manufacturing and testing of these transformers, in compliance with most current NEMA, IEEE and Industry standards and practices.
5. Transformer Loss Calculations based on primary and secondary voltage and current differences measured simultaneously.

3.5 PROTECTION

A. Physically protect transformers against damage. All field-repairs to be performed by and approved by factory-authorized service representative at no added cost to Owner:
   1. Touch-up scratches and removed paint with original factory paint.
   2. Replace dented plates and panels.
   3. Replace scratched, discolored, or otherwise damaged nameplate labels.

3.2 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results. All test reports on transformers shall be compile to one database and this must be submitted to the Owner.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltage and tap settings.

3.3 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

SECTION 26 24 16 – 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. Comply and follow with the SMSD – MEP Electrical Standards

1.2 SUMMARY

A. Section Includes:
1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

A. SPD: Surge protective device (suppressor).

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and over-current protective device, surge suppression Protective device (SPD), accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

A. Coordination Drawings: Provide coordination drawings as described in 26 05 00 paragraph 1.03(C).

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 over-current protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual over-current 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 over-current protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of over-current protective device.
9. Fault current rating, brazing and bus rating

C. Qualification Data: For qualified testing agency.

D. 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.

E. Panelboard Schedules: For installation in panelboards.

F. 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 over-current protective devices.
   2. Time-current curves, including selectable ranges for each type of over-current protective device that allows adjustments.

1.5 QUALITY ASSURANCE

B. Source Limitations: Obtain panelboards, over-current protective devices, components, and accessories from single source from single manufacturer.

A. 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.

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 PB 1.

D. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 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.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than two weeks days in advance of proposed interruption of electric service.
   2. Comply with NFPA 70E.

1.8 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.

A. 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.

1.9 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.

1.10 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. Keys: Two spares for each type of panelboard cabinet lock. All keys shall be turn-in to SMSD Owner.
   2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
   3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

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. Wash-Down Areas: NEMA 250, Type 4X stainless steel.
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 5.
   2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
   3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   4. Door in door Hinges: For ease of access to branch circuit wiring.
   5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:
8. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pre-treating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   a. Back Boxes: Same finish as panels and trim.
9. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn Copper, 98 percent conductivity.
2. Coating: Electroplated with Tin to a minimum thickness of 30 micron.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
6. Split Bus: Vertical buses divided into individual vertical sections.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Sub-feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and over-current protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series-connected ratings are not acceptable.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D / Schneider Electric
2. Cutler-Hammer / Eaton
3. General Electric / ABB
4. Siemens

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 high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Over-current 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.

G. Branch Over-current Protective Devices: Circuit Breaker.

H. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D / Schneider Electric
   2. Cutler-Hammer / Eaton
   3. General Electric / ABB
   4. Siemens

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Over-current Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series-connected ratings are not acceptable.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for over-current protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. 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. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
   2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to panelboards.
   5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 90 inches above finished floor unless otherwise indicated.

F. 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. Mount surface panelboards on 1-5/8 x 1-5/8 Unistrut not on wall surface.

G. Install over-current protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade. All empty conduits shall be enclosed or sealed.

J. All conduits, junction boxes, pull boxes and entering and leaving shall be marked or label with circuit numbers.

K. Conductors inside the panelboards shall be install neat, order and workmanlike manner. Comply and refer to NEC Article 312.

L. 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."

A. 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.

B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. 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. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test 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.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection report, 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.

A. Set field-adjustable circuit-breaker trip ranges as indicated.

B. 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.

B. Physically protect panelboards against damage. All field-repairs to be performed by and approved by factory-authorized service representative at no added cost to Owner:
   1. Touch-up scratches and removed paint with original factory paint.
   1. Replace dented plates and panels.
   2. Repair or replace damaged or non-functional devices.
   3. Replace scratched, discolored, or otherwise damaged nameplate or device identification labels.

3.1 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

B. Clean the outside and inside the switchboards free from dust.

END OF SECTION 26 24 16

SECTION 26 27 26 - 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. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
4. Hospital Grade
5. Wall-box motion sensors.
6. Isolated-ground receptacles.
7. Snap switches and wall-box dimmers.
8. Wall-switch and exterior occupancy sensors.
9. Communications outlets.
10. Pendant cord-connector devices.
11. Cord and plug sets.
12. Floor service outlets, poke-through assemblies, service poles, and multi-outlet 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. SPD: Surge suppressor protective device.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 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.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configuration.
   1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Service/Power Poles: One for every 10, but no less than one.
   2. Floor Service Outlet Assemblies: One for every 10 but no less than one.
   3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
   4. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

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. Pass & Seymour/Legrand
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).

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. Pass & Seymour/Legrand ; 5381 (single), 5352 (duplex).
      b. Hubbell; HBL5351 (single), CR5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).

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. Pass & Seymour; 63H
      b. Hubbell; HBL8300SG.
      c. Leviton; 8300-SGG.

2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, 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. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour/Legrand; 2084.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Receptacles: Comply with NEMA WD 1, NEMA WD 6 configuration and ratings as indicated on Drawings, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour/Legrand
      b. Hubbell
      c. Leviton

B. Isolated-Ground, Single Receptacles:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell
      b. Leviton
      c. Pass & Seymour/Legrand
   2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.5 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
   1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
   2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.6 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
   2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour/Legrand; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (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).

C. Pilot Light Switches, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour/Legrand; PS20AC1-PLR for 120 V.
      b. Hubbell; HPL1221PL for 120 V and 277 V.
      c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 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. Pass & Seymour/Legrand; PS20AC1-L.
      b. Hubbell; HBL1221L.
      c. Leviton; 1221-2L.
   2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour/Legrand; 1251.
      b. Hubbell; HBL1557.
      c. Leviton; 1257.

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour/Legrand; 1251L.
      b. Hubbell; HBL1557L.
      c. Leviton; 1257L.

2.8 WALL-BOX DIMMERS

A. Dimmer Switches: By same manufacturer of other devices to match dimming technology of connected light fixtures.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

2.9 OCCUPANCY SENSORS

A. Wall-Switch Sensors:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour/Legrand
      b. Hubbell
      c. Leviton
      d. Watt Stopper

2. Description: Dual technology Passive-infrared type/Ultrasonic, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.

B. Long-Range Wall-Switch Sensors:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; ATD1600WRP.
   b. Leviton; ODW12-MRW.
   c. Watt Stopper (The); DT-200.
   d. Pass & Seymour/Legrand
2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.

C. Wide-Range Wall-Switch Sensors:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; ATP120HBRP.
   b. Leviton; ODWHB-IRW.
   c. Pass & Seymour; HS1001.
   d. Watt Stopper (The); CX-100-3.
2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.

D. Exterior Occupancy Sensors:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Leviton; PS200-10.
   b. Watt Stopper (The); EW-100-120.
   c. Pass & Seymour/Legrand
2. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.10 COMMUNICATIONS OUTLETS

A. Telephone Outlet:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 3560-6.
   b. Leviton; 40649.
2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

B. Combination TV and Telephone Outlet:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 3562.
   b. Leviton; 40595.
2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.11 WALL PLATES

A. Single and combination types to be 302/304 stainless steel.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.12 FLOOR SERVICE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; System One.

B. Type: Modular, flush-type, dual-service units suitable for wiring method used.

C. Compartments: Barrier separates power from voice and data communication cabling.

D. Service Plate: Rectangular, solid brass, coordinate finish with Architect prior to ordering.

E. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

F. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.13 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; System One.

B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/fire-stop unit and detachable matching floor service outlet assembly.
   1. Service Outlet Assembly: Pedestal type with services indicated.
   2. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
   3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   4. Closure Plug: Arranged to close unused 3-inch cored openings and reestablish fire rating of floor.
   5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.14 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Wire: Minimum No. 12 AWG.

2.15 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
   1. Poles: Nominal 2.5-inch square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.

2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
3. Finishes: Manufacturer's standard painted finish and trim combination.
4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
6. Voice and Data Communication Outlets: Blank insert with bushed cable opening.

2.16 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: Ivory, or as selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

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. Cut holes need not to be more than 1/8” inch in all sides of the box.
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. Boxes and conduit shall be rigidly supported to the wall. Do not use spacer type supports.
5. Install wiring devices after all wall preparation, including painting, is complete.
6. Do not use extension ring in any applications.

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 300.14, without pigtails. Multiple duplex receptacles shall be use pigtail and use the screw terminals to terminate the wire not the back of the receptacle outlet.
4. Conductors shall be identified with circuit number at the box.
5. Existing Conductors:
   Cut back and pigtail or replace all damaged conductors.
   a. Straighten conductors that remain and remove corrosion and foreign matter.
   b. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. 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 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 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 black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
2. Receptacles: Label or marked the cover with panel and circuit number back and front cover.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. 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 26 27 26

SECTION 26 28 13 - 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 control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches, fuse-holders, and panelboards.
3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
4. Spare-fuse cabinets.

1.3 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.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

B. 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.

1.4 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.

1.5 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

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.

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. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 PLUG FUSES

A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.4 PLUG-FUSE ADAPTERS

A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuse-holders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 SPARE-FUSE CABINET

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Service Entrance: Class L, fast acting.
   2. Feeders: Class L, fast acting
   3. Motor Branch Circuits: Class RK1 and Class RK5, time delay.
   4. Other Branch Circuits: Class J, fast acting.
   5. Control Circuits: Class CC, fast acting.

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 fuse-holders 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 26 28 13

SECTION 26 28 16 - 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. Non-fusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers.
6. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, 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. Detail features, characteristics, ratings, and factory settings of individual over-current protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of over-current protective device; include selectable ranges for each type of over-current 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.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.

E. 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.

F. Manufacturer's field service report.

G. 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 over-current protective device; include selectable ranges for each type of over-current protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, over-current protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. 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.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.6 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.

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.
   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.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D / Schneider Electric
   2. Cutler-Hammer / Eaton
   3. General Electric / ABB

4. Siemens

B. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: 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. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: 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.

D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hook stick Handle: Allows use of a hook stick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.
9. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D / Schneider Electric
2. Cutler-Hammer / Eaton
3. General Electric / ABB
4. Siemens

B. Type HD, Heavy Duty, Single Throw, 240, 600-V 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. Type HD, Heavy Duty, Six Pole, Single Throw, 240, 600-V ac, 200 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.

D. Type HD, Heavy Duty, Double Throw, 240, 600-V 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.

E. 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: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hook-stick Handle: Allows use of a hook-stick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D / Schneider Electric
2. Cutler-Hammer / Eaton
3. General Electric / ABB
4. Siemens

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. 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. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system, specified in Division 26 Section "Electrical Power Monitoring and Control."
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
7. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Electrical Operator: Provide remote control for on, off, and reset operations.

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.
3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, SS-304.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X SS-304.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

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. 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. 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.

C. 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.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection report, 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 26 28 16

SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600V and less:
   1. Full-voltage manual.
   2. Full-voltage magnetic.
   3. Reduced-voltage magnetic.
   4. Reduced-voltage solid state.
   5. Multi-speed.

B. Related Section:
   1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200HP.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Over-current protective device.

G. SCR: Silicon-controlled rectifier.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
   1. Show tabulations of the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Nameplate legends.
      d. Short-circuit current rating of integrated unit.
      e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
      f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: For enclosed controllers, 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.

E. Field quality-control reports.

F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for enclosed controllers and installed components.
   2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
   3. Manufacturer's written instructions for setting field-adjustable overload relays.
   4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 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. 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 NFPA 70.

D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Owner no fewer than 10 days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical systems without Owner's written permission.
4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

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. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than 2 of each size and type.
3. Indicating Lights: 2 of each type and color installed.
4. Auxiliary Contacts: Furnish 1 spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish 3 spares for each size and type of magnetic contactor installed.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Square D.
   b. GE.
   c. Cutler-Hammer.
   d. Asco

2. Configuration: Non-Reversing.
3. Surface mounting.
4. Red pilot light.

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Square D.
   b. GE.
   c. Cutler-Hammer.
   d. Asco
2. Configuration: Non-reversing.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button.
4. Surface mounting.
5. Not all manufacturers offer a green pilot light; pilot lights are not available in hazardous and some cast-type enclosures.
6. Red pilot light.

D. Magnetic Controllers: Full voltage, across the line, electrically held.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Square D.
   b. GE.
   c. Cutler-Hammer.
   d. Asco
2. Configuration: Non-reversing.
3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
4. Control Circuits: 120 V ac; obtained from integral CPT, with primary and secondary fuses and sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
5. Solid-State Overload Relay:
   a. Switch or dial selectable for motor running overload protection.
   b. Sensors in each phase.
   c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
   d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
   e. Analog communication module.
6. External overload reset push button.

E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Square D / Schneider Electric
   b. Cutler-Hammer / Eaton
   c. General Electric / ABB
   d. Siemens
2. MCP Disconnecting Means:

a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
d. N.C. alarm contact that operates only when MCP has tripped.
e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3. MCCB Disconnecting Means:
   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
   b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
   e. N.C. alarm contact that operates only when MCCB has tripped.

2.2 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 3R.
   3. Kitchen and Wash-Down Areas: Type 4X, stainless steel.
   4. Other Wet or Damp Indoor Locations: Type 4X-ss.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: Type 12.
   6. Hazardous Areas Indicated on Drawings: Type 9.

2.3 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Heavy duty, oil-tight type.

B. N.C., N.O. auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Under-voltage and Over-voltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable under-voltage, over-voltage, and time-delay settings.

E. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

F. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

H. Cover gaskets for Type 1 enclosures.

I. Terminals for connecting power factor correction capacitors to the load side of overload relays.

J. Spare control wiring terminal blocks, quantity as indicated; unwired.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

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 each fusible-switch enclosed controller.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

F. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Install power factor correction capacitors. Connect to the line/load side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified 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 nameplate.
   3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures. Use ‘Panduit’ where possible.

C. Connect selector switches and other automatic-control selection devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
   2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 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. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Perform the following infrared (thermo graphic) 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 multi-pole enclosed controller. 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 multi-pole enclosed controller 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.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 26 29 13

SECTION 26 43 13 – SURGE PROTECTION DEVICES 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes field-mounted SPD's for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Sections:
1. Division 26 Section "Switchboards" for factory-installed SPD's.
2. Division 26 Section "Panelboards" for factory-installed SPD's.
3. Division 26 Section "Wiring Devices" for devices with integral SPD's.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. SVR: Suppressed voltage rating.

C. SPD: Surge Protective Device(s), both singular and plural..

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

B. Qualification Data: For qualified testing agency- (NRTL) National Recognized Testing Laboratory

C. Product Certificates: For SPD devices, from manufacturer.

D. Field quality-control reports.

E. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.

F. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA or the equipment manufacturer to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

D. Comply with UL 1283 and UL 1449 (current edition).

E. The SPD installation complies with NFPA 70.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Owner no fewer than four days in advance of proposed electrical service interruptions.
   2. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 COORDINATION

A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.

B. Coordinate SPD devices with Division 26 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five (5) 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. Where equipment design uses replaceable protection modules: One (1) of each size and type installed.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D.
   2. GE.
   3. Eaton/ Cutler-Hammer.
   4. Liebert
   5. Current Technology Inc.; Danaher Power Solutions.
   6. Leviton

B. Surge Protection Devices:
   1. Comply with UL 1449 (current edition).
   2. Modular design.
   3. Fuses, rated at 200-kA interrupting capacity.
   4. Fabrication using bolted compression lugs for internal wiring.
   5. Integral disconnect switch or circuit breaker.

6. Redundant suppression circuits.
7. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
8. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
9. LED indicator lights for power and protection status.
10. Audible alarm, with silencing switch, to indicate when protection has failed.
11. Form-C contacts rated at 1 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
12. Six-digit transient-event counter set to totalize transient surges.

C. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral:1200 V for 480Y/277 V, 700 V for 208Y/120 V.
2. Line to Ground: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.

2.2 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D.
2. GE.
3. Eaton/ Cutler Hammer.
4. Advanced Protection Technologies Inc. (APT).
5. Current Technology Inc.

B. Surge Protection Devices:
1. Non-modular.
2. LED indicator lights for power and protection status.
3. Audible alarm, with silencing switch, to indicate when protection has failed.
4. Form-C contacts rated at 1 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

C. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
2. Line to Ground: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.

2.3 ENCLOSURES

A. Indoor Enclosures: NEMA 250 Type 1.

B. Outdoor Enclosures: NEMA 250 Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground at the SPD. Ground only at NEC required locations.
1. Provide manufacturer’s approved circuit breaker as applicable as a dedicated disconnecting means for SPD unless otherwise indicated.

3.2 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.
1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
3. Complete startup checks according to manufacturer's written instructions.

C. SPD device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Do not energize or connect service entrance equipment, panelboards, control terminals or data terminals to their sources until SPD devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train. Owner's maintenance personnel to maintain SPD devices.

END OF SECTION 26 43 13

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SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Follow and comply with the SMSD MEP Electrical Standards.

1.2 SUMMARY

A. This Section includes the following:
1. Interior lighting fixtures and drivers.
2. Emergency lighting units.
3. Exit signs LED lighted
4. Lighting fixture supports.

B. Related Sections include the following:
1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multiple lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
3. Division 26 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.

C. Submittals:
1. Provide cut-sheets and summary all types of fixtures for review.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. RCR: Room cavity ratio.

G. LED Light Emitted Diode

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast.
4. Energy-efficiency data.

5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."
6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
7. Life, output, and energy-efficiency data for lamps.
8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
   a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
   b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
   1. Wiring Diagrams: Power and control wiring.

C. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
   1. Lamps: Specified units installed.
   2. Accessories: Cords and plugs.

D. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

E. Qualification Data: For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

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.

D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

E. Mockups: Provide interior lighting fixtures for room or module mock-ups, complete with power and control connections.
   1. Obtain Architect's approval of fixtures for mockups before starting installations.
   2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Lighting Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
   2. Warranty Period for Emergency Fluorescent Ballast Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
   2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: Two (2) year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Battery and Charger Data: One for each emergency lighting unit.
   4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
   5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to 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, manufacturers specified.

C. Luminaires, Acceptable Manufacturers:
   1. Cooper
   2. Genlyte
   3. General Electric
   4. Hubbell
   5. Kenall
   6. Lithonia

D. Lamps, Acceptable Manufacturers:
   1. General Electric
   2. Osram Sylvania
   3. North American Phillips

E. Ballasts, Acceptable Manufacturers:
   1. Advance Transformer Co.
   2. Universal Lighting Technology
   3. Osram
   4. Sylvania

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

A. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

F. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metalized Film: 90 percent.

G. Plastic Diffusers, Covers, and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
   b. UV stabilized.
2. Glass: Annealed crystal glass, unless otherwise indicated.

H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures, indicated to require a filter, with one filter per ballast.

I. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."
1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat Removal Units: Air path leads through lamp cavity.
3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
4. Dampers: Operable from outside fixture for control of return-air volume.
5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: 20 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.88 or higher.
7. Power Factor: 0.95 or higher.
8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electronic Programmed-Start Ballasts for T5 Lamps: Comply with ANSI C82.11 and the following:
1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.95 or higher.

C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

1. Ballast Manufacturer Certification: Indicated by label.

D. Ballasts for Low-Temperature Environments:
   1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting and operating temperature with indicated lamp types.

E. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

F. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

G. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
   1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
      a. High-Level Operation: 100 percent of rated lamp lumens.
      b. Low-Level Operation: 30 percent of rated lamp lumens.
   2. Ballast shall provide equal current to each lamp in each operating mode.
   3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. BF: 0.95 or higher, unless otherwise indicated.
   9. Power Factor: 0.95 or higher.
   10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
   11. Ballast Case Temperature: 75 deg C, maximum.

B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate 1 fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect un-switched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Night-Light Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
   a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:
   1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
   3. Normal Ambient Operating Temperature: 104 deg F.
   4. Open-circuit operation that will not reduce average life.
   5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Sound Rating: A.
   3. Total Harmonic Distortion Rating: Less than 15 percent.
   4. Transient Voltage Protection: IEEE C62.41, Category A or better.
   5. Lamp Current Crest Factor: 1.5 or less.
   6. Power Factor: .90 or higher.
   7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
   8. Protection: Class P thermal cutout.
   9. Retain subparagraph and associated subparagraphs below for bi-level ballasts.
   10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.
      a. High-Level Operation: 100 percent of rated lamp lumens.
      b. Low-Level Operation: 35 percent of rated lamp lumens.
      c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
   11. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.

a. Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.
b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.

C. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.

D. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
1. Instant Re-strike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
a. Re-strike Range: 105- to 130-V ac.
b. Maximum Voltage: 250-V peak or 150-V ac RMS.
2. Minimum Starting Temperature: Minus 40 deg F.
3. Open-circuit operation shall not reduce average lamp life.

2.7 EXIT SIGNS LED LIGHTED

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
2. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
a. Battery: Sealed, maintenance-free, nickel-cadmium type.
b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
4. Master/Remote Sign Configurations:
a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.

b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.8 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 5 minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
   4. Install at least ~~one~~ FOUR independent support rod or wire from BUILDING structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aim-able lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

A. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.3 CLEANING

A. Clean the diffuser or lenses before installing to the fixture.

END OF SECTION 26 51 00

SECTION 26 55 00 – BUILDING LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Digital Occupancy and Daylighting Sensor Control
   2. Emergency Lighting Control

1.2 RELATED SECTION

A. Section [260926 – Lighting Control Panel Boards:] Lighting panels (switching) controlled by Digital Network Lighting Control System.

B. Section [260936 – Modular Dimming Controls:] Digital Lighting Management

C. Section [265113 – Interior Lighting Fixtures, Lamps, and Ballasts:] Fluorescent electronic dimming ballasts.

D. Section [25000 – Integrated Automation] Building integrator shall provide integration of the lighting control system with Building Automation Systems.

E. Drawings and general provision of the Contact, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section

F. Electrical Sections, including wiring devices, apply to the work of this Section.

1.3 CONTROL INTENT – CONTROL INTENT INCLUDES, BUT IS NOT LIMITED TO:

A. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.

B. Initial sensor and switching zones

C. Initial time switch settings

D. Emergency Lighting control

1.4 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)

B. Underwriter Laboratories of Canada (ULC)

C. International Electrotechnical Commission (www.iec.ch)

D. International Organization for Standardization (ISO)

E. National Electrical Manufacturers Association (NEMA) (www.nema.org)

F. WD1 (R2005) - General Color Requirements for Wiring Devices.

G. Underwriters Laboratories, Inc. (UL) (www.ul.com):

1. 916 – Energy Management Equipment.
2. 924 – Emergency Lighting

1.5 SYSTEM DESCRIPTION & OPERATION

A. The Lighting Control and Automation system as defined under this section covers the following equipment:
   1. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relays controllers with integral current thyristor, 0-10 volt control for ballasts (if applicable) and single relay application-specific plug load controllers.
   2. Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
   3. Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
   4. Digital Photosensors – Single-zone closed loop and multi-zone open loop daylighting sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylight harvesting.
   5. Configuration Tools – Handheld remote for room configuration provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send and receive of room variables and store of occupancy sensor settings. Computer software also customizes room settings.
   6. Handheld remotes for personal control – One-button dimming, two-button on/off, or five-button scene remotes provide control using infrared communications. Remote may be configured in the field to control selected loads or scenes without special tools.
   7. Digital Lighting Management (DLM) local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
   8. Network Bridge – provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS).
   9. Segment Manager – provides web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
   10. Emergency Lighting Control Unit (ELCU) – allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

1.6 SUBMITTALS

A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.

B. Shop Drawings:
   1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).
   2. Scale drawing for each area showing exact location of each sensor, room controller, network bridges, digital plug load room controller, segment managers, and digital switch.

C. Product Data: Catalog sheets, specifications and installation instructions.

D. Include data for each device which:
   1. Indicates where sensor is proposed to be installed.
   2. Prove that the sensor is suitable for the proposed application.

1.7 QUALITY ASSURANCE

A. Manufacturer: Minimum [10] years' experience in manufacture of lighting controls.

1.8 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 0° to 40° C (32° to 104° F).
   2. Relative humidity: Maximum 90 percent, non-condensing.

1.9 WARRANTY

A. Provide a five year complete manufacturer's warranty on all products to be free of manufacturers' defects.

1.10 MAINTENANCE

A. Spare Parts:
   1. Provide five (5) spares of each product listed below to be used for maintenance. Electrical contractor shall deliver items to SMSD maintenance within 30 days of substantial completion.
      a. Room Controllers
      b. Occupancy Sensors
      c. Emergency Bypass controllers
      d. Low voltage switches
      e. Daylighting harvesting photocells

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:
   1. WattStopper (713)572-4000 (No substitutions)

2.2 SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS

A. Type PW: Manual-ON, Automatic-OFF passive infrared (PIR) wall switch occupancy sensor Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper PW-100, PW-200, PW-103, PW-203, PW-301, PW-302, WS-301..

B. Type UW: Manual-ON, Automatic-OFF ultrasonic wall switch occupancy sensor with Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper UW-100, UW-200.

C. Type DW: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper DW-100, DW-200, DW-103, DW-203, DSW-100, DSW-200, DW-103, DW-203, DSW-301, DSW-302.

2.3 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and

electrical system parameters. Passive infrared only sensors shall not be used for classroom applications.

B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
   1. Digital calibration and pushbutton programming for the following variables:
      a. Sensitivity – 0-100% in 10% increments
      b. Time delay – 1-30 minutes in 1 minute increments
      c. Test mode – Five second time delay
      d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
      e. Walk-through mode
      f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
   2. One or two RJ-45 port(s) for connection to DLM local network.
   3. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
   4. Device Status LEDs including:
      a. PIR Detection
      b. Ultrasonic detection
      c. Configuration mode
      d. Load binding
   5. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
   6. Manual override of controlled loads.

C. Units shall not have any dip switches or potentiometers for field settings.

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

E. All devices shall be hard wired. No wireless devices shall be permitted.

F. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.4 DIGITAL WALL SWITCHES

A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening. Wall switches shall include the following features:
   1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
   2. Removable buttons for field replacement with engraved buttors and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
   3. Red configuration LED on each switch that blinks to indicate data transmission.
   4. Blue Load/Scene Status LED on each switch button with the following characteristics:
      a. Bi-level LED
      b. Dim locator level indicates power to switch
      c. Bright status level indicates that load or scene is active
   5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

B. Two RJ-45 ports for connection to DLM local network.

C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.

D. The following switch attributes may be changed or selected using a wireless configuration tool:
   1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
   2. Individual button function may be configured to Toggle, On only or Off only.
   3. Individual scenes may be locked to prevent unauthorized change.
   4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
   5. Ramp rate may be adjusted for each dimmer switch.
   6. Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

E. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

2.5 ROOM CONTROLLERS

A. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
   1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
   2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
   3. Device Status LEDs to indicate:
      a. Data transmission
      b. Device has power
      c. Status for each load
      d. Configuration status
   4. Quick installation features including:
      a. Standard junction box mounting
      b. Quick low voltage connections using standard RJ-45 patch cable
   5. Plenum rated
   6. Manual override and LED indication for each load
   7. Dual voltage (120/277 VAC, 60 Hz)
   8. Zero cross circuitry for each load.

B. On/Off/Dimming enhanced Room Controllers shall include:
   1. Real time current monitoring
   2. One, two or three relay configuration
   3. Efficient 250 mA switching power supply
   4. Four RJ-45 DLM local network ports.
   5. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
   6. The following dimming attributes may be changed or selected using a wireless configuration tool:
      a. Establish preset level for each load from 0-100%
      b. Set high and low trim for each load
      c. Set lamp burn in time for each load up to 100 hours

7. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMRC-221, LMRC-222, LMPL-201

2.6 DIGITAL PHOTOSENSORS

A. Digital photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Photosensors shall be interchangeable without the need for rewiring.

B. Digital photosensors include the following features:
1. An internal photodiode that measures only within the visible spectrum, and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
2. Sensor light level range shall be from 1-10,000 footcandles (fc).
3. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
4. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the “ON Setpoint” and the “OFF Setpoint” that will prevent the lights from cycling after they turn off.
5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a user-selectable minimum level.
6. Optional programmable wall switch override to allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.
7. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
8. Red configuration LED that blinks to indicate data transmission.
9. Blue status LED indicates test mode, override mode and load binding.
10. Recessed switch to turn controlled load(s) ON and OFF.
11. One RJ-45 port for connection to DLM local network.
12. An adjustable head and a mounting bracket to accommodate multiple mounting methods and building materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.

C. Closed loop digital photosensors include the following additional features:
1. An internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from bright sources outside of this cone.
2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
3. Automatically establishes setpoints following self-calibration.
4. A sliding setpoint control algorithm for dimming daylight harvesting with a “Day Setpoint” and the “Night Setpoint” to prevent the lights from cycling.
5. WattStopper Product Number: LMLS-400.

D. Open loop digital photosensors include the following additional features:
1. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.

2. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.
3. A proportional control algorithm for dimming daylight harvesting with a “Setpoint” to be maintained during operation.
4. WattStopper Product Number: LMLS-500.

2.7 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
1. 120/277 volts, 50/60 Hz., 20 amp ballast rating
2. Push to test button
3. Auxiliary contact for remote test or fire alarm system interface

B. WattStopper Product Numbers: ELCU-100, ELCU-200.

2.8 ROOM NETWORK (DLM LOCAL NETWORK)

A. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building. Digital room devices connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:
1. Plug n’ Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
3. Push n’ Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

2.9 LIGHTING CONTROL PANELS

A. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

B. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 – 8 relays, 1 – 24 relays and 6 four-pole contactors, or 1 – 48 relays and 6 four-pole contactors.

C. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.

D. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:

1. Removable, plug-in terminal blocks with screwless connections for all low voltage terminations.
2. Individual terminal block, override pushbutton, and LED status light for each relay.
3. Direct wired switch inputs associated with each relay and group channel shall support two-wire, momentary or maintained contact switches.
4. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches, digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs, digital IO modules capable of receiving momentary or maintained contact closure inputs, digital photocell modules, and digital occupancy sensors.
5. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
6. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
7. Group, channel, and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override pushbuttons and LED displays for channels 1-9 or a handheld IR programmer for channels 1-99.
8. Relay group status for each channel shall be provided through red LED indicators for groups 1-9 and via BACnet for groups 1-99. Solid red indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
9. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
10. Electrical:
    a. 30 amp ballast at 277V
    b. 20 amp ballast at 347V
    c. 20 amp tungsten at 120V
    d. 30 amp resistive at 347V
    e. 1.5 HP motor at 120V
    f. 14,000 amp short circuit current rating (SCCR) at 347V
    g. Relays shall be specifically UL listed for control of plug loads
11. Mechanical:
    a. Individually replaceable, ½" KO mounting with removable Class 2 wire harness.
    b. Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
    c. Dual line and load terminals each support two #14 – #12 solid or stranded conductors.
    d. Tested to 300,000 mechanical on/off cycles.
12. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
13. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
14. Lighting control panels shall be WattStopper model LMCP8, LMCP24 or LMCP48 as shown on the plans.

2.10 BACNET® BASED DIGITAL COMMUNICATIONS

A. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 master/slave token passing-based using the BACnet® protocol.

B. The panel shall have provision for an individual BACnet device ID. The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.

C. The panel shall support MS/TP MAC addresses in the range of 0 – 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.

D. Lighting control relays shall be controllable as binary output objects in the instance range of 1 – 64. The state of each relay shall be readable and writable by the BAS via the object present value property.

E. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 – 64.

F. The 99 channel groups associated with the panel shall be represented by binary value objects in the instance range of 201 – 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.

G. Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
   1. Binary output objects in the instance range of 1 – 64 (one per relay) for on/off control of relays.
   2. Binary value objects in the instance range of 1 – 99 (one per channel) for normal hours/after hours schedule control.
   3. Binary input objects in the instance range of 1 – 64 (one per relay) for reading true on/off state of the relays.
   4. Analog value objects in the instance range of 1 – 64 (one per relay) shall assign relays to channel groups in the range of 1 – 99.
   5. Analog value objects in the instance range of 101 – 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute gracetime period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
   6. Analog value objects in the instance range of 201 – 299 (one per channel) shall assign an after hours time delay value to the channel in the range of 1 – 240 minutes.
   7. Multi-state value objects in the instance range of 1 – 99 (one per channel) shall provide the state of the relays assigned to the channel. Valid states shall be ALL ON, MIXED, BLINK, and ALL OFF.
   8. The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
   9. The BO and BV 1 – 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (http://www.bacnet.org/Addenda/Add-135-2010aa.pdf)
   10. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
   11. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

12. Lighting control accessory devices connected to the panel shall be represented via BACnet objects including but not limited to the following:
13. Digital occupancy sensor detection states shall be readable as BI objects ranging from BI1-96.
14. Digital occupancy sensor configuration parameters shall each be accessible as BACnet objects when applicable to a given product.
    a. Occupancy sensor time delay in minutes shall be writeable via AV101-196.
    b. Occupancy sensor passive infrared (PIR) sensitivity percentage shall be writeable via AV201-296.
    c. Occupancy sensor ultrasonic (US) sensitivity percentage shall be writeable via AV301-396.
15. Digital switch buttons shall be readable and writeable as BI objects ranging from BI101 – 9608.
16. Digital daylight sensors foot-candle readings shall be readable as follows:
    a. Analog 0-5V/0-10V sensors connected to a digital input module shall be represented as AI1-96.
    b. Digital closed loop sensors shall be represented as AI4001-4096.
    c. Digital open loop sensors shall be represented as AI5001-5096.
    d. Digital dual loop sensors shall be represented as follows:
17. The upward facing open loop sensor shall be represented as AI6001-6096.
18. The downward facing closed loop sensor shall be represented as AI6101-6196.
19. Digital daylight sensor configuration shall be exposed as BACnet objects as follows:
20. Digital closed loop sensors shall be represented as follows:
21. Daylight Sensor Day Setpoint (ftcd) AV4201-4296.
22. Daylight Sensor Night Setpoint (ftcd) AV4301-4396.
23. Daylight Sensor Off Setpoint Delay (minutes) AV4401-4496.
24. Daylight Sensor On Setpoint (ftcd) AV4501-4596.
25. Daylight Sensor Off Setpoint (ftcd) AV4601-4696.

2.11 USER INTERFACE

A. Each lighting control panel system shall be supplied with at least (1) handheld IR remote programming interface consisting of a keypad and associated OLED display screen. The user interface shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following functions as a minimum:

B. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.

C. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.

D. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.

E. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.

F. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.

G. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minmum LAT, LON, DST zone, and an approximate city/state location.

H. An additional handheld IR remote may optionally be specified to be permanently mounted to the panel interior via a retractable anti-theft lanyard to allow for convenient programming of the panel while assuring that the handheld programmer is always present at that panel. An unlimited number of handheld IR remotes may also be purchased for facilities staff as seen fit by the end user's representative.

2.12 CONFIGURATIONS TOOLS

A. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface.

B. Features and functionality of the wireless configuration tool shall include:
   1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
   2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
   3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
   4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
   5. Temporarily adjust light level of any load(s)on the local network, and incorporate those levels in scene setting.
   6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

C. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

2.13 NETWORK BRIDGE

A. The network bridge connects a DLM local network to a BACnet-compliant network for communication between rooms, panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication. Closed or proprietary network communication shall not be acceptable.
   1. The network bridge may be incorporated directly into the room controller hardware (LMRC-3xx Room Controllers) or be provided as a separate module connected on the local network through an available RJ-45 port.
   2. Provide Plug n' Go operation to automatically discover all room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
   3. The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. Standard BACnet objects shall be provided as follows:

      Read/write the normal or after hours schedule state for the room
      a. Read the detection state of the occupancy sensor
      b. Read/write the On/Off state of loads

c. Read/write the dimmed light level of loads
d. Read the button states of switches
e. Read total current in amps, and total power in watts through the room controller
f. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
g. Activate a preset scene for the room
h. Read/write daylight sensor fade time and say and night setpoints
i. Read the current light level, in footcandles, from interior and exterior photosensors and photocells
j. Set daylight sensor operating mode
k. Read/write wall switch lock status

4. WattStopper product numbers: LMBC-300

2.14 SEGMENT MANAGER

A. The Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall serve up a graphical user interface via a standard web browser. Each segment manager shall have support for one, two or three segment networks as required and allow for control of a maximum of 40 local networks (rooms) and/or lighting control panels per segment network.

B. Operational features of the Segment Manager shall include the following:
1. Connection to PC or LAN via standard Ethernet TCP/IP.
2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser.
3. Log in security capable of restricting some users to view-only or other limited operations.
4. Automatic discovery of all DLM devices on the segment network(s). Commissioning beyond activation of the discovery function shall not be required.
5. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
6. Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation.
7. Ability to set up schedules for rooms and panels. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation.
8. Ability to group rooms and loads for common control by schedules, switches or network commands.
9. Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature.
10. Provide seamless integration with the BAS via BACnet IP. Provide export table with available parameters.

2.15 REALTIME COLOR GRAPHICS

A. System Description
1. Color graphics screens shall allow a user to monitor and control the lighting control system through a graphical color interface. The system will control the room controllers in a real-time environment.
2. The application will provide a visual representation of the floor plan, drawn to scale, with each fixture displayed on screen. Fixtures can automatically indicate the relay controlling them on screen.

B. Graphic Screen Generation
1. The General Contractor shall provide as built CAD floor plans to the manufacturer for generation of graphic screens.

2. As-Built relay panel and reflected ceiling documentation must be provided to the manufacturer before graphic screen development can begin. Graphic screens will be provided and demonstrated to the owner within 90 days of receiving as built CAD files.

C. District Wide Home Screen
   1. Links to all existing WattStopper Schools in the district

D. School Home Screen
   1. School Rendering
   2. Day/ Time
   3. Schedule for that day
   4. Exterior FC reading
   5. Current Lighting Watts per ft
   6. Plug load watts per ft

E. Quick Access System tree
   1. Links 3
   2. 65 day Scheduler

F. Site Plan
   1. All exterior lighting shown on/ off

G. Screens per floor
   1. For navigation and showing lighting on/off

H. Detail screen per architectural area
   1. Room Occupancy (room shaded green)
   2. Lighting states (3 zones with override)
   3. Real time wattage for lighting
   4. Real Time Wattage for plug load
   5. Real time Photocell footcandle reading if applicable

I. Alarms Reports

J. WattStopper Product Numbers: LMSM-6E.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor shall provide to the manufacturer all quantities for system including but not limited to relays, room controllers, relay panels, plug load controllers, switches, sensors and wire lengths and configurations for both network and device cable at least 1 week before bid.

B. When using wire for connections other than the DLM local network (Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements

C. All MSTP network and Cat 5e low voltage wiring must have “WattStopper” printed on the wire jacket. Any cable substitutions shall be removed and replaced at the contractor’s expense.

D. All MSTP network terminations shall utilize wire ferrules for terminations and MSTP network manufacturer’s instructions. Any network deficiencies shall be repaired at the contractor’s expense.

E. Electrical contractor must provide a detailed as-built plan in CAD showing MSTP network cable routing and network bridge serial numbers to the manufacturer at least 2 weeks prior to factory commissioning Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.

3.2 FACTORY COMMISSIONING

A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

B. The factory commissioning shall include the following services. Programming of all button stations, configuration of all occupancy sensors and photocells. Verification of a complete and working system including MSTP network status. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
   3. Load Parameters (e.g. blink warning, etc.)

C. The electrical contractor shall request factory commissioning by submitting a startup request form at least (4) weeks before startup is required.

D. The electrical contractor shall provide at least (1) journeyman electrician, familiar with the installation of the system, dedicated to assisting the factory start-up technician for the entire duration of the commissioning process.

E. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.3 RE-COMMISSIONING

A. After 90 days from occupancy the factory authorized representative and electrical contractor shall re-calibrate all sensor time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity

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SECTION 26 55 61 - MIDDLE SCHOOL THEATRICAL LIGHTING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Due to the specialty nature of theatrical lighting equipment, a Theatrical Systems Contractor shall provide the theatrical dimming and control equipment to the Project Electrical Contractor, as well as providing support and coordination services to ensure a complete working system.
   1. The Theatrical Systems Contractor shall be an authorized dealer of the specified manufacturers and have been actively engaged in the sales, installation, repair and maintenance of theatrical lighting equipment for no less than five full (5) years. Evidence of experience for projects of similar size and scope shall be submitted if requested. This evidence shall include a reference list for a minimum of five projects including: job name, contact name and phone number, scope and contract value.

C. The intent of this specification is to define parameters for furnishing and installing a complete and working new dimming and control system. Performance deviations will not be accepted.

D. All work must be in compliance with the National Electric Code and applicable local codes. All equipment, wiring and appurtenances necessary for a complete, working and code compliant installation shall be provided whether detailed or not.

1.2 SCOPE OF WORK

A. This section includes the following lighting control system equipment
   1. Dimmers
   2. Controls
   3. Distribution
   4. Lighting instruments, lamps, and associated rigging

B. Work under this section shall include the furnishing of all labor, materials, tools, transportation services, supervision, etc., necessary to complete the installation of new stage equipment as detailed in these specifications and accompanying documents.

C. The Theatrical Systems Lighting Contractor shall be responsible for the following:
   1. Provide all dimming, control, and distribution equipment as detailed and required in these specifications and associated drawings
   2. Provide shop drawings indicating system layout, control wiring, physical mounting locations, and mounting techniques of all equipment
   3. Install pipe mounted circuit boxes and raceways as required
   4. Provide Factory Authorized Service Technician to perform system commissioning, low voltage terminations, installation of control plates, system programming, and minimum 4 hours training to Owner's Representative.
   5. Provide all lighting fixtures and accessories as indicated or required. All fixtures shall be unboxed, lamped, aligned, hung, and focused.

D. The Project Electrical Contractor shall be responsible for the following, with performance requirements as specified in other Division 26 specifications:
   1. Installation of all dimming and control racks and equipment, including mounting of racks on walls, power feeds as required, and installation of custom back boxes.
   2. Provision and installation of all standard back boxes

3. Provision and installation of all 120v distribution circuits, and all 120/208v feeder circuits for the theatrical lighting system
4. Terminating of all 120v and 120/208v power and distribution circuits, both in the dimmer cabinet, and at the circuit distribution.
5. Provision and installation of all conduit, junction boxes, electrical wire ways, and cable trays as required for the lighting systems, including low voltage control systems.
6. Pulling all high and low voltage cable into conduit
7. Clean all racks, panels, and boxes of dirt, dust, and debris, re-assemble all equipment, and replace all panels, covers, and screws prior to time of system factory energization and training.

E. All components necessary to make the system a complete and working lighting system shall be provided.

F. Verify site conditions and system layout during the project approval process, coordinating with other trades as required.

1.3 SUBMITTALS

A. General: Submit the following in accordance with the conditions of contract and Division 1 Specification Sections.
1. Product data for lighting instruments, lamps, distribution components, and control systems. Include dimensions and data on features and components. Include wiring diagrams and elevation views of front panels of control and indicating devices. Include illustrations and dimensioned outline drawings of fixtures. Include data on ratings and features of devices.
2. Maintenance data for control systems for inclusion in Operating and Maintenance Manual specified in Division 1.
3. Specification Review: Line by line marked-up copy of the specification indicating compliance or detailed deviation.

B. Substitutions: Specific items of equipment are listed by trade names. The Owner has determined that these are the particular items desired by the Owner and that they have established a standard of quality, equipment function and/or process.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 “National Electrical Code” for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms “Listed” and “Labeled” are as defined in the National Electrical Code, Article 100.

C. Electrical or electronic equipment provided under this Division which has been damaged, exposed to weather, or is, in the opinion of the Architect/Engineer otherwise unsuitable because of improper fabrication, storage, or installation, shall be removed and replaced with new equipment, at no additional cost to the Owner.

D. To ensure a uniform installation and single responsibility, one manufacturer shall provide all dimming and control system components. Mixing of equipment brands will not be accepted.

E. To ensure a quality installation, the installing firm must be regularly engaged in the business of installation of stage equipment.

F. The system shall be supplied through an authorized dealer for local support and fixture focusing duties.

G. Contractor / Manufacturer shall provide local on-site service for the system for a period of one year from date of substantial completion. A service facility, including at least one full-time technician and a spare parts inventory, shall be located within 100 miles of the job site. This person or firm must be regularly engaged in the service of theatrical dimmers. A salesperson or sales agent without dedicated service personnel does not meet this requirement.

H. This specification details specific operational and functional needs of the Owner. Deviations from the performance requirements will not be accepted from any supplier. Contractor assumes the responsibility of removing any non-complying material discovered during the warranty period and replacing it with specification compliant equipment.

1.5 DRAWINGS

A. The Owner shall be supplied with "as-built" drawings.

B. Operations and maintenance manuals, covering all major items installed, shall be provided for each of the venues.

C. All Drawing requirements for submittals and as built detailed general sections of specification shall apply.

D. Provide lighting plot layout for the Owner's approval prior to installation of fixtures. Install and focus fixtures per approved plot. Plot shall indicate all circuit numbers, fixture placement, circuit, channel, color, focus information, hanging locations, whether used or unused, and control locations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Equipment
   1. Dimming equipment, control equipment, portable lighting fixtures: Approved manufacture: Electronic Theatre Controls
   2. Circuit raceways and distribution: Approved manufacturers: Electronic Theatre Controls

2.2 DIGITAL MINI PANELS

A. Mini Panels
   1. Digital Panels for lighting and pluggable loads shall be the Foundry Mini Panel by ETC, Inc
   2. Mechanical
      a. Mini Panels shall be constructed of 16AWG steel and finished in a black fine-texture powder paint.
      b. The Mini Panel shall be no larger than 9" x 12" x 3.5" for 4 output models or 14" x 12" x 3.5" for 8 output models
      c. Mini Panels shall support wall and ceiling mounting, including installation in Plenum air return spaces.
      d. A removable dead front cover shall be mechanically fastened using four screws.
      e. An internal safety cover made of 16AWG steel shall prevent access to all line voltage (class1) wiring and components without limiting access to low voltage terminations, changing settings during commissioning, or manual control of relays.
      f. Mini Panels shall support onboard configuration without the use of software using a simple two-button interface to set start address
      g. The Mini Panel shall support an input for use in UL 924 Emergency Systems
         1) A dry contact input shall provide triggering of an emergency condition

2) A three position switch shall set the input as Normally Open (NO) Normally Closed (NC), or Off
3) Load shedding shall be supported via a two position switch per zone, that includes or excludes each zone from the UL924 input

h. The Mini Panel shall support a Demand Response input to automatically reduce overall power consumption.
1) A dry contact input shall be supported to trigger the demand response condition
2) A single rotary dial shall be available for each to set the maximum trim level when the input is active

i. All configuration buttons shall be fully accessible when the Panel is mounted and the front panel is removed.

j. Mini Panels shall provide the following LED indicators:
1) UL924 Active (red)
2) Demand Response Active (green)
3) Power OK (blue)
4) DMX Signal/Error (green)

3. Electrical
a. Power Input shall support 120-277 Volts AC 47-63Hz for control electronics and for each independent zone. Daisy Chain of an input to multiple control zones shall be supported
b. Mini Panels shall provide an optional 20A single-phase normal sense feed input for UL 924 Emergency Lighting Control Bypass
c. A voltage barrier shall be available to separate normal and emergency circuits or lighting and plug loads when combined in a single Panel. The barrier shall be constructed of UL94-V-0 plastic
d. All Mini Panels shall provide a 20 Ampere, fully rated, normally open relay for each output rated for lighting and plug load use
e. A 0-10V dimming output per zone shall support 0-10V sink control rated for 100mA per output
f. Mini Panels shall support Class 2, ANSI E1.11-2008, USITT DMX512A control communications
1) Mini Panels shall provide a DMX512A wiring connection using terminal blocks for #24 AWG wire
a) Terminal blocks for Cat5e or better wire shall also be available
2) The control network shall utilize unshielded twisted pair, Belden 9729 or equivalent wire, plus one #14 ESD drain wire (when not installed in grounded metal conduit). Use of Category 5e, or better, control network wiring shall also be supported when utilizing appropriate termination kits available from the manufacturer
g. Mini Panels shall be designed and tested to withstand discharges up to 15,000 volts (IEC 801-2) without impairment of performance.
h. Mini Panels shall provide a three position terminal for power input to the control electronics. The control power input shall accept 6-14AWG wire and be clearly marked Line, Neutral and Earth Ground
i. Each relay shall provide three screw terminals for line voltage power connection. Each terminal shall accept 6-14awg wire and be clearly labeled Input, Output and Thru. Panels that do not support a single power input to multiple discrete relays, in any combination, shall not be accepted.
j. Mini Panels shall support 0-10V dimming control via two 16-26AWG terminals for 0-10V+ and 0-10V common wiring connections
k. Mini Panels shall be UL and cUL LISTED and conform to UL 508 and UL 2043 (Plenum rated) standards

4. Functional
a. Mini Panels shall be available in 4 or 8 zone configurations with a 20 Ampere, fully–rated, relay output and 0-10V dimming per zone

b. Mini Panels shall be UL924 approved for emergency lighting circuits and shall activate only the selected outputs. Excluded loads shall be shed and not output during emergency conditions
c. Mini Panels shall support Demand Response input via contact closure. Upon input the Panel shall reduce maximum output to 70% of peak usage. 0-10V outputs shall support Demand response maximum level threshold adjustment using a rotary fader, and shall be assignable per circuit while measuring usage.
d. Upon loss of power, Mini Panels shall return to their last state when power returns
e. Mini Panels shall support commissioning without the use of software or specialty configuration tools. Panels that require software for configuration shall not be acceptable
f. All Mini Panels shall be configurable via ANSI E1.20 Remote Device Management (RDM). RDM parameters shall include:
   1) Device Label – configure a name for the device
   2) DMX Start Address –set the starting DMX address of the Zone Controller to a value from 1-512
   3) DMX Fail Mode (Data Loss) – configure the Zone Controller behavior when DMX is lost: Hold last look, Wait and fade, Go to full (default)
   4) Packet Delay – configure the number of packets required before the zone controller activates a change of level (relay on/off or 0-10V output)

B. Mini Panels that are not configurable over RDM shall not be acceptable.

2.3 ARCHITECTURAL CONTROL STATIONS

A. Function: The system shall be designed to allow control of lighting and associated systems via Preset/Fader, LCD, IR or Astronomical time clock controls. Provide Touchscreen LCD Station with Color Picker Controls for Control of Color Changing LED Fixtures.

B. System macros (sequences) shall be programmable via Light Manager system software.
   1. Macro sequence steps shall include preset selection, wall status change, station property change (template), zone property change, timed delay, jump to macro, and stop macro.
   2. Macro sequences shall be activated by button, time clock event or Light Designer software.

C. System time clock events shall be programmable via Light Designer system software, Web Browser Interface, through the LCD Touchscreen Station.
   1. Time clock events shall be assigned to system day types. Standard day types include: any day, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
   2. Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using daylight savings time.

D. Station (Preset/Fader, LCD or IR) control components shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via Light Designer, the Windows-based configuration program.
   1. Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, cue light, or room join/separate.
   2. Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.
   3. Stations (Preset/Fader, LCD and IR) shall allow programming of station and component electronic lockout levels via Light Designer.

E. Electrical
   1. Control station wiring shall be an Echelon® Link power network.

2. Echelon® Link Network wiring may be bus, loop, home run or any combination of these.

2.4 LIGHTING CONSOLE AND ACCESSORIES

A. General:

2.5 FIXTURES

A. Front of House Ellipsoidals shall be a ETC Color Source LED Color Changing Spot as manufactured by Electronic Theatre Controls, Inc. Provide Fixtures complete with c-clamp, safety cable, enhanced definition lens, smooth wash diffuser, Edison connectors or powercon pass through cables, and DMX cables. Fixtures shall be black.

B. LED overhead wash fixtures shall be Color Source LED PAR Deep Blue Color Changing Fixtures, as manufactured by Electric Theatre Controls. Provide Fixtures complete with c-clamp, safety cable, lens, Edison connectors or powercon pass through cables, and DMX cables. Fixtures shall be black.

C. All fixtures shall be supplied complete with all necessary accessories: hanging clamp, appropriate connector, lenses, lamp, and safety cable.

D. All fixtures shall have a 5 year manufacturer warranty on the entire fixture, and a 10 year warranty on the light array.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all new equipment and rewire existing equipment, all in compliance with national and local electrical codes. Auxiliary equipment required making this installation comply with codes, even if not listed in the specification, shall be the responsibility of the contractor and shall be included at no additional cost to the Owner.

B. All wiring shall be installed in a craftsman-like manner. When conductors must be spliced to extend length, it shall be with a terminal strip or suitable type compression fittings.

C. Equipment shall be kept clear of all metal shavings, wire scraps, and miscellaneous trash. Any abandoned holes in the floor shall be patched.

D. Any existing conduit emanating from the floor shall be dressed in such a manner as to eliminate any trip hazard. Conduits shall be re-routed or terminated into wire-ways to insure a neat installation.

E. All equipment shall be installed in compliance with applicable local and national codes. It shall also be installed in accordance with the manufacturer's recommendations. Prior to initial energizing, a factory certified technician shall inspect the system and any errors shall be corrected.

F. Install equipment according to manufacturer’s written instructions.

G. Set permanently mounted items plumb and level and square with ceilings and walls.

H. Mount and connect fixtures. Arrange as so each fixture, each dimmer can be operated and the system demonstrated in all operating modes.

I. Mounting of Equipment shall conform to manufacturer's instructions and industry standards.

J. Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounted items.

K. Field verify location with Owner/Architect exact location of remote DMX512 input receptacle(s), fader stations, front beam, and border light.

L. Provide pipe battens as required. Support pipe battens to building structure to support equipment with safety factor.

3.2 IDENTIFICATION

A. Identify components and power and control wiring as specified.

B. Label each fixture, lighting outlet, and dimmer module with a unique designation. Make designations on elevated components readable from the floor.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between control devices as recommended by manufacturer. Install wiring in raceway except cable and plug connections.

B. Wiring in Enclosures: Bundle, train, and support.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Arrange and provide for the service of a factory authorized service representative with theatrical lighting and control experience to test, adjust, aim, focus and program the lighting control system. Final aiming shall be as directed by Owner/Architect. Final programming of the dimmer and all pre-sets shall be as directed by the Owner and Architect. Initial presets shall be set with master at 95-percent.

B. Visual and Mechanical Inspections: Include the following:
   1. Inspect each fixture, outlet, module, and item of equipment for defects, finish failure, corrosion, and physical damage, UL/NRTL labeling, and nameplate.
   2. Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's instructions or routine functional operation.
   3. Check tightness of electrical connections with torque wrench calibrated within the previous 6 months. Use manufacturer's recommended torque values.
   4. Verify proper protective device settings and fuse types and ratings.

C. Electrical Tests: Perform according to manufacturer's instructions.
   1. Insulation resistance tests of conducting parts of control components and connecting supply feeder and control circuits. Minimum acceptable insulation resistance is 100 megohms or greater.
   2. Continuity tests of circuits.

3.5 CLEANING AND ADJUSTING

A. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars of finish to match original finish. Clean fixtures, devices, and equipment, internally and externally, using methods and materials as recommended by manufacturers.

3.6 DEMONSTRATION

A. Demonstrate functions, features, and adjustments for each fixture with fixture energized and operating with the indicated lamp.

B. Demonstrate the system to provide compliance with requirements.

C. Direct Training: Arrange and provide for the services of a factory authorized service representative to demonstrate lighting control system and train Owner's personnel.
   1. Conduct a minimum of 4-hours of training in operation and maintenance. Include training relating to system operation and maintenance procedures.
   2. Schedule training with at least a 14-working day advance notification.

3.7 COMMISSIONING

A. Operational Tests: Energize lighting controls systems, program controls, and check controlled outlets for light levels. Program test scenes so every fixture is tested throughout its operating range with the installed lamp. Check programmed function at each control station. Adjust components and revise installation to correct deficiencies.

B. Correct deficiencies and retest deficient items. Verify by the system tests that specified requirements are met.

3.8 SERVICES

A. Services of a qualified technician, representing the manufacturer, and employed full time in the service of control systems, shall be provided. This technician shall terminate all low voltage control wiring, inspect the installation, and energize the system. He shall also instruct the owner in proper operation and maintenance of the system.

B. During the warranty period, the manufacturer shall provide a toll-free 24-hour-per-day number for telephone technical support and service request.

3.9 WARRANTY

A. The manufacturer shall provide a one (1)-year warranty on the entire lighting control system from date of substantial completion.

3.10 RIGGING

A. Stage Contractor shall install lighting positions labeled FOH (front of house) 1st electric, 2nd Electric, and 3rd electric. Pipe shall be 1.5" schedule 40. Pipe shall be mounted to structure such that pipe will not twist or turn.

3.11 BILL OF MATERIALS

Quantity	Item
1	ETC Foundry 6 Circuit Relay Panel
1	ERn2 Architectural Control Rack
1 1	P-ACP: Architectural Control Processor P-SPM: Paradigm Station Power Module
1	Wall Mount DMX/RDM OptoSplitter

Quantity	Item
2	DMX In Station
1	P-LCD: Paradigm Touchscreen Station
16	ETC Color Source PAR Deep Blue, w/ Pipe clamp, Edison connector, DMX, cable, and WFL Lens
12	ETC Color Source Spot 26 degree w/ Pipe clamp, gel holder, stage pin connector, safety cable
4	Pipe Mounted Black DMX Out
6	1 Circuit Pipe Mount Pigtail Boxes w/ 36” Edison Connector
1	ETC Element 2 Control Console, with Dust Cover, and 25’ DMX Cable
2	DVI Monitors for Element Console

END OF SECTION 26 55 61

SECTION 26 90 20 - ELECTRICAL CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of Division 16 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section. Follow and comply with the SMSD MEP Electrical Standards.

1.2 SECTION INCLUDES

A. Cabinets.

B. Relays/Contactors.

C. Photo cells.

D. Time clocks.

E. Power supplies.

F. Terminal blocks.

G. Plastic wiring troughs.

H. Miscellaneous.

1.3 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

A. Shop Drawings: Provide complete point to point wiring diagrams inside low voltage panels and from panels to control/switching sources. Provide shop drawings indicating all conduit sizes and locations required for switching system.

B. Product Data: Provide for each device specified. Indicate coil and contact ratings, dimensions, cabinets and accessory items.

C. Provide category and UL file number for products.

D. Warranties.

E. Submittals for this section shall be signed by the subcontractor responsible for Division 13 controls, also.

PART 2 - PRODUCTS

2.1 CABINETS

A. Factory mount relays, time clocks, power supplies, terminal blocks, wiring troughs and accessories in a NEMA 1 cabinet conforming to Section 260533 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS by a UL 508 listed manufacturer unless otherwise directed.

B. Contactors/relays shall be individually identified with name tags. All wiring within cabinets shall be pre wired through plastic wiring troughs and brought to terminal blocks for field connections. Wires at terminal blocks and contactors/relays shall be identified by contactor/relay and pole number.

C. Low voltage control wiring shall conform to Section 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES 600V wires and cables.

D. Provide 1/4" minimum spacing between non-power limited wiring and power limited wiring.

E. Cabinet and components shall be suitable for installation and operation in an unconditioned space.

F. Relay cabinet power shall be 120 volts or as otherwise indicated.

G. Cabinets shall be lockable, keyed alike. Furnish two (2) keys for each cabinet.

H. Provide wire bending space, clearances, construction, etc. in accordance with NEC-312.

2.2 RELAYS/CONTACTORS

A. Provide mechanically held SPST Class A150 contacts of required number, voltage, and current rating conforming to NEMA ICS 2 and UL 508 "industrial control equipment." Contacts shall be fully field convertible from N.O. to N.C.
   1. Magnetic Control Relay: Class A300.
   2. Time Delay Relay: Class A600.

B. Control coil shall be Class 2 power limited with solid state control accessories as required.

C. Line and low voltage terminals shall be screw type.

D. Relays shall be ASCO 917 with 47, 48 or 49 Series control modules as required or equal by General Electric, Square D, Westinghouse/Cutler-Hammer, Siemens/ITE

2.3 PHOTO CELLS

A. Photocell switch manufactured to NEMA ICS 2 and UL 773A "Non-industrial Photoelectric Switches for Lighting Control."

B. Provide voltage, NEMA rating, contact rating and contact configuration as required.

C. Sensitivity two (2) footcandles to 50 footcandles, adjustable.

D. Provide photo cells manufactured by Intermatic, Dayton, Paragon or Tork.

2.4 TIME CLOCKS

A. Provide 24 hour clock timer manufactured to NEMA ICS 2 and UL 917 "Clock Operated Switches" with two (2) astronomic time setting and 12 hour spring wound reserve power carry over.

B. Manufacturers: Intermatic, Dayton, Paragon, Tork.

2.5 POWER SUPPLY

A. Provide low voltage power supply in conformance with NEC Article 725 Class 2 and UL 1585 "Class 2 and Class 3 Transformers."

B. Provide transformer size, primary, secondary fusing and accessories as required.

C. Manufacturers: General Electric, Square D, Westinghouse, Dormeyer, White Rodgers.

2.6 TERMINAL BLOCKS

A. Conform to NEMA ICS 4 and UL 486A "Wire Connectors and Soldering Lugs for use with Copper Conductors."

B. Provide phenolic, channel mount, screw type terminals.

C. Manufacturers: General Electric, Square D, Westinghouse, Cutler/Hammer, Buchanan, Allen-Bradley, Entrelec, Pass & Seymour/Legrand, Thomas and Betts, Marathon, Ilsco.

D. Provide UL listed copper ground terminal.

2.7 PLASTIC WIRING TROUGHS

A. Provide open slot vinyl wiring duct with snap on cover conforming to NEMA ICS 6 of width and height as required.

B. Manufacturers: Gould Shawmut, Panduit, Rob Roy, Tyton, Electrovert, Pass & Seymour/Legrand, Leviton.

2.8 MISCELLANEOUS

A. Provide miscellaneous items (diodes, solid state relays, logic chips, fuse holders, etc.) as required for a complete operating system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish all labor, materials, tools, equipment, and services for interface with HVAC controls, lighting controls, and other control systems as indicated and required by contract documents. Relays, conduit, wiring and accessories required shall be provided and installed.

B. Completely coordinate with work of all other trades.

C. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. Mount control panels where indicated on drawings and provide proper NEC working clearance assuming panel will require examination while energized.

E. Use manufacturer's recommended cable size for length of run and relays served.

F. Provide conduit and wire between control panels, power panels, relays and low voltage switches as required to achieve the sequence of operation indicated.

G. Inside relay cabinets, provide 1/4" minimum spacing between non-power limited wiring and power limited wiring. Otherwise, power limited wiring shall be in separate enclosures from non-power limited wiring.

3.2 DEMONSTRATION

A. Provide system demonstration under provisions of contract closeout.

END OF SECTION 26 90 20

SECTION 26 95 00 - FIELD ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of Division 26 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section.

1.2 SECTION INCLUDES

A. Testing by Installing Contractor

B. Testing by Independent Certified Testing Contractor

C. All testing shall be witness with the Owner, Commissioning Agent, Engineer or Architect.

1.3 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

A. Contractor shall submit experience and certified of testing firm and individuals who will be performing and evaluating tests before any tests are done.

B. Contractor shall submit in writing at least 24 hours in advance notification of the occurrence of any test described in this section.

C. Contractor shall record all test data and submit three (3) copies for review. In addition to the test data, each record shall include; date of test, ambient temperature, climate conditions, instruments used, names of test personnel and witnesses and identification of items tested.

D. The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

1.4 QUALITY ASSURANCE: COMPLY WITH THE FOLLOWING.

A. All tests shall be done in accordance with all applicable codes and standards.

B. Qualifications of Testing Firm:
   1. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
   2. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
   3. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, or be a Full Member company of the International Electrical Testing Association (IETA).
   4. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing services.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DIVISION OF RESPONSIBILITY

A. All tests indicate in this specification section shall be done by the testing firm except the installing

contractor shall be responsible for the following:

1. The contractor shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.
2. 120 Volt General Purpose Receptacles: All 120 volt general purpose receptacles shall be tested for correct connection using a Hubbell Catalog #5200 or equal receptacle tester.
3. 120 Volt Ground Fault Circuit, Interrupter (GFCI) Receptacles: All 120 volt GFCI receptacles shall be tested for correct connection and rating using Hubbell Catalog #GFT-2G with a range of 2 to 7 milliamps.
4. Enclosed (Disconnect) Switches: Subsequently to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.
5. Light Switching: Verify proper connection and operation of switches for lighting fixtures.
6. Lighting Contactors: Demonstrate proper operation of lighting contactors for all items indicated in Division 16.
7. Balancing Loads: After Substantial Completion, but not more than two months after Final Acceptance, conduct load-balancing measurements on panelboards and circuit changes as follows:
   a. Perform measurements during period of normal working load as advised by the Owner.
   b. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   c. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
   d. Tolerance: Difference between phase loads exceeding 20 percent at any one panelboard is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

B. The Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.

C. The Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

D. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported to the Owner/Engineer's representative replaced or repaired by the Contractor at no cost to the Owner, and retested.

E. An electrical system will not be accepted until tested in its entirety and results reported to the Owner.

3.2 TESTING FIRM

A. The testing firm shall test the following equipment as indicated in each section:
   1. 600V Wire and Cables
   2. Grounding and Bonding.
   3. Dry Type Transformers.
   4. Enclosed Motor Controllers

5. Motor Control Center
6. Panelboards
7. Switchboards/Switchgear

3.3 INFRARED BASELINE SCANNING

A. Provide scanning for Switchboards, Transformers, MCC's, Panelboards, Generator connection points, Copper Busses, Circuit Breakers, Terminations and Transfer Switches.

B. After Substantial Completion, but not more than two (2) months after Final Acceptance, perform an infrared IR scan in Section 26-95-00 Part 3, 3.2 of each panelboard, switchboard and pad mounted transformer. Remove fronts to make joints and connections accessible to a portable scanner.

C. Instrument: Use an approved infrared IR scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.

D. Record of Infrared IR Scanning: Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 95 00

SECTION 31 31 50 - BUILDING EARTHWORK

PART 1 GENERAL

1.01 REQUIREMENTS, CODES:

A. All applicable portions of Division 1 - The Contract for Construction, along with General, and Supplementary Conditions of the Contract for Construction are to be considered as included with this section.

B. The following are minimum requirements and shall govern, except that all federal, local and/or state codes and ordinances shall govern when their requirements are in excess hereof.

1.02 DESCRIPTION:

A. Provide all materials labor, equipment, service, etc., necessary and incidental to the completion of necessary excavating and backfilling for buildings and structures. as shown on the drawings and as specified herein.

B. Carefully and thoroughly examine the drawings, specifications, and field conditions and provide all work as required under this section.

1.03 DEFINITIONS:

A. Backfill: Soil material used to fill an excavation, not within the building lines.

B. Borrow Soil: Satisfactory soil imported from off-site for use as select fill or backfill.

C. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Remove all unsuitable material encountered in the field.
2. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by City Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
3. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.
4. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by City Engineer. Unauthorized excavation, as well as remedial work directed by City Engineer, shall be without additional compensation.

D. Select Fill: Soil materials used to raise existing grades and backfilling.

E. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

F. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

G. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.04 SUBMITTALS

A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

B. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.

C. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.

D. Pre excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.05 QUALITY ASSURANCE

A. Pre excavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.06 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by City Engineer or others unless permitted in writing by City Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

B. Notify City Engineer not less than two days in advance of proposed utility interruptions.

C, Do not proceed with utility interruptions without City Engineer's written permission.

D. Contact utility-locator service for area where Project is located before excavating.

E. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Borrow or on-site soils consisting of non-active inorganic sandy lean clay, having a Plasticity Index between 12 and 20 percent, and with not more than 40 percent retained on a No. 200 sieve may be used for select fill.

D. Borrow or on-site soils having Plasticity Index greater than 20 may be used as select fill if stabilized with approximately 5 to 7 percent hydrated lime.

E. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

F. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

C. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

B. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.04 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm) within the building lines and to 5-feet beyond the building lines. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

B. Excavations for Grade Beams: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.05 SUBGRADE INSPECTION

A. Notify City Engineer when excavations have reached required subgrade.

B. If City Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slab and 5-feet beyond the building line with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

D. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph (5 km/h).

E. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).

F. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by City Engineer, and replace with select fill as directed.

G. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

H. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by City Engineer, without additional compensation.

3.06 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under grade beams by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by City Engineer.

3.07 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

B. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.08 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Place backfill on subgrades free of mud, frost, snow, or ice.
7. Place backfill as soon a practical to prevent ponding of surface water adjacent to the grade beams.

3.09 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

C. Under building slabs, use select fill.

D. Under steps and ramps, use select fill.

E. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

B. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

C. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.11 COMPACTION OF SOIL BACKFILLS AND SELECT FILLS

A. Place backfill and select fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and select fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Then compacted to a minimum of 95% maximum density ASTM D-1557 (90% in landscaped areas) at its optimum moisture content ± 2%.

D. Compact soil materials to not less than the following percentages of maximum dry density according to ASTM D 698:

E. Under building slabs and steps, scarify and recompact top 6 inches (150 mm) of existing subgrade and each layer of backfill or select fill soil material to at least 95 percent at a moisture of between optimum and 3 percent wet of optimum moisture.

3.12 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Provide a smooth transition between adjacent existing grades and new grades.

C. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

D. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

E. Aprons and walks: Plus or minus 1/4 inch (6.4 mm).

F. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: The Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each select fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

D. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than 3 tests.

E. Grade Beam Backfill: At each compacted backfill layer, at least 1 test for each 100 feet (30 m) or less of perimeter length, but no fewer than 2 tests.

F. When testing agency reports that subgrades, select fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.14 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Scarify or remove and replace soil material to depth as directed by City Engineer; reshape and recompact.

D. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

E. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Transport surplus satisfactory soil to designated storage areas on City Engineer's property. Stockpile or spread soil as directed by City Engineer.

B. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off City Engineer's property.

END OF SECTION

SECTION 31 63 29 - DRILLED CONCRETE PIERS AND SHAFTS

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. Dry-installed drilled piers.
   2. Slurry displacement-installed drilled piers.
   3. Dry-installed or slurry displacement-installed drilled piers at Contractor's choice.

1.3 UNIT PRICES

A. Unit prices are included in Section 01 22 00 "Unit Prices."

B. Drilled Piers: Actual net volume of drilled piers in place and approved. Actual length, shaft diameter, and bell diameter if applicable, may vary, to coincide with elevations where satisfactory bearing strata are encountered. These dimensions may also vary 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. Base bids on indicated number of drilled piers and, for each pier, the design length from top elevation to bottom of shaft, extended through the bell, if applicable, and the diameter of shaft and bell.
   2. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, testing and inspecting, and other items for complete drilled-pier installation.

C. Trial Drilled Pier: Unit price as indicated for drilled pier, including backfilling.

1.4 SUBMITTALS

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

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Shop Drawings: For concrete reinforcement detailing fabricating, bending, supporting, and placing.

D. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.

E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

F. Field quality-control reports.

G. Other Informational Submittals:
1. Record drawings.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.

B. Testing Agency Qualifications: Qualified according to ASTM C 1077, ASTM D 3740, and ASTM E 329 for testing indicated.

C. Drilled-Pier Standard: Comply with ACI 336.1 unless modified in this Section.

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. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
1. Notify all affected parties including Owner no fewer than five (5) days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

C. 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 this data.
1. Make additional test borings and conduct other exploratory operations necessary for drilled piers.
2. The geotechnical report is referenced elsewhere in the Project Manual.

D. 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.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Refer Section 03 20 00.

2.2 CONCRETE MATERIALS

A. Refer Section 03 30 00 and Structural General Notes.

2.3 STEEL CASINGS

A. Steel Pipe Casings: ASTM A 283, Grade C, or ASTM A 36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1.

B. Corrugated-Steel Pipe Casings: ASTM A 929, steel sheet, zinc coated.

2.4 CONCRETE MIXTURES

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.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

C. Proportion normal-weight concrete mixture as follows:
   1. As indicated in Structural General Notes.

2.5 FABRICATING REINFORCEMENT

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

2.6 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 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 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: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
   1. Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time will be authorized for removal of obstructions.
   2. Obstructions: Unclassified excavated materials may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. Payment for removing obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work will be according to Contract provisions for changes in the Work.

B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

C. Excavate shafts for drilled piers to indicated 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.

D. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. 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. Payment for additional authorized excavation will be according to Contract provisions for changes in the Work.

E. Excavate shafts for closely spaced drilled piers and for drilled piers 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 placing concrete.

H. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.
   1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.

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 over 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. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete. 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 reinforcement, place concrete with chutes, tremies, or pumps.
   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. If 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 more than 90 deg F.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Drilled piers.
   2. Excavation.
   3. Concrete.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.
   1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities will be determined by testing and inspecting agency. Final evaluations and approval of data will be determined by Architect.

D. Concrete Tests and Inspections: ASTM C 172 except modified for slump to comply with ASTM C 94.
   1. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
   2. Concrete Temperature: ASTM C 1064; 1 test hourly when air temperature is 40 deg F and below and 80 deg F and above, and 1 test for each set of compressive-strength specimens.
   3. Compression Test Specimens: ASTM C 31; one set of four standard 6-inch x 12-inch cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
   4. Compressive-Strength Tests: ASTM C 39; one set for each drilled pier but not more than one set for each truck load. One specimen will be tested at 7 days, 2 specimens will be tested at 28 days, and 1 specimen will be retained in reserve for later testing if required.
   5. If frequency of testing will provide fewer than five strength tests for a given class of concrete, testing will be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   6. If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
   7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
   8. Report test results in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. List 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 in reports of compressive-strength 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 will make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by Architect.
      a. Continuous coring of drilled piers may be required, at Contractor's expense, if temporary casings have not been withdrawn within specified time limits or if

observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.

11. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports for each drilled pier as follows:
1. Actual top and bottom elevations.
2. Actual drilled-pier diameter at top, bottom, and bell.
3. Top of rock elevation.
4. Description of soil materials.
5. Description, location, and dimensions of obstructions.
6. Final top centerline location and deviations from requirements.
7. Variation of shaft from plumb.
8. Shaft excavating method.
9. Design and tested bearing capacity of bottom.
10. Levelness of bottom and adequacy of cleanout.
11. Ground-water conditions and water-infiltration rate, depth, and pumping.
12. Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
13. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
14. Bell dimensions and variations from original design.
15. Date and time of starting and completing excavation.
16. Inspection report.
17. Condition of reinforcing steel and splices.
18. Position of reinforcing steel.
19. Concrete placing method, including elevation of consolidation and delays.
20. Elevation of concrete during removal of casings.
21. Locations of construction joints.
22. Concrete volume.
23. Concrete testing results.
24. Remarks, unusual conditions encountered, and deviations from requirements.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 31 63 29